Part III. Extended Flight Phase, Second Annual Period (July 1, 1967 – July 1, 1968)

I. Introduction

Deep Space Network support of *Pioneer VI* continued to meet and, in some instances, surpass Project requirements. Support during this reporting period included spacecraft coverage of solar flares in November and April. There was also a requirement for reorientation of the spacecraft antenna with earth on pass 620 in August. The maneuver (type II) was performed satisfactorily despite a spacecraft storage bottle leak, which depleted the propulsion gas supply. A total of 193 commands were transmitted on the pass.

A significant change in support was caused by loss of the use of the high-gain antenna aboard the spacecraft in late 1967, which finally resulted in abandonment of attempts to transmit commands for the remainder of this reporting period. A significant improvement in downlink signal strength was obtained in March with the DSS 14 reconfiguration for ultracone. Tracking interruptions were a result of the *Mariner V* encounter with Venus and the Pulsar Observation Project. All tracking was accomplished by DSS 14; the bit rate was 8 bits/s.

When the annual report period began, the *Pioneer VI* spacecraft was some 231 million km from earth. At the end of the period, the spacecraft was some 293 million km from earth, the greatest distance of separation reached thus far. The spacecraft began retrograde motion on September 16 while approximately 238 million km from earth; by November it had come approximately 6 million km nearer earth before again starting to recede.

II. Engineering and Operations

A. Tracking

Pioneer VI was tracked by DSS 14 for a total of 1107 h 15 min during the period from July 1, 1967 to July 1, 1968 (passes 564 through 928). The tracking time by quarter was as follows:

Tracking period	Passes	Total tracking time, h-min
Jul, Aug, Sep 1967	564–648	309:7
Oct, Nov, Dec 1967	675–746	212:36
Jan, Feb, Mar 1968	747–837	228:2
Apr, May, Jun 1968	838–928	357:30

B. Significant Problems and Improvements

Loss of the ability to track the spacecraft in a two-way coherent mode was the most serious problem that developed during the second annual period of the *Pioneer VI* extended flight phase. The most significant improvement during the period was transfer of the DSS 14 antenna to an ultracone configuration (Fig. 20). The S-band Cassegrain ultracone, which had been modified at JPL for polarization diversity, was installed on March 5. *Pioneer* spacecraft radiated linearly polarized signals, and the DSS antennas used a circularly polarized feed. Because of this, only half the received signal was indicated at the receiver. Use of the linear-to-circular polarizer at DSS 14 improved the downlink signal strength from the spacecraft by some 5 dBmW above predicted value for one-way tracking modes.

1. Tracking interruptions. The longest tracking interruption during the report period was from September 24 to October 21, 1967. During this time (pass 648 to pass 675), the *Pioneer VI* spacecraft was not tracked by DSS 14 because of the priority of the *Mariner V* encounter with Venus. There was also a four-day interruption in April 1968 for the Pulsar Observation Project.

2. Tracking mode. Prior to October, *Pioneer VI* was tracked most of the time in two-way mode on channel 7. But after the tracking interruption for the *Mariner* Venus encounter, two major problem areas developed, beginning as small error indications and increasing in magnitude.

The first problem was a station problem. Loss of word/frame (W/F) synchronization in the TCP printout occurred at random, but because of low error rate the loss was not considered excessive at the time. When the loss of W/F sync increased, the source of the problem was traced to several bad cards in the computer buffer. The cards were replaced.

The second problem area seemed to be within the spacecraft. The ground receiver had random momentary glitches, and the ground transmitter had to be increased from 10- to 15-kW output for the spacecraft to accept commands. Ground receivers, the transmitter, and the microwave lines checked out satisfactorily in analysis. On following passes the receiver glitches increased to more than one per min in both one- and two-way configurations. The transmitter was increased to 20 kW, but ultimately no commands were acceptable on channel 7.

Two-way tracking was maintained for a period on channel 6 by using spacecraft receiver 1. However, use of channel 6 lowered the threshold because it made necessary dependence on a low-gain antenna instead of a high-gain antenna (Fig. 21).

The problem of spacecraft acquisition of commands became greater when receiver 2 broke into oscillation and cross-feeding impaired receiver 1. Finally, it was no longer possible to maintain two-way lock in coherent mode on channel 6. However, before channel 6 became too noisy to accept commands, a noncoherent command was initiated in November. For a period, tracking was performed in a two-way noncoherent mode. In this mode, receiver 1 was locked on the station transmitter via channel 6 with a control loop between the receiver and the auxiliary (driver) oscillator. This permitted reception of commands by the spacecraft. Consequently, the downlink carrier frequency from the spacecraft was independent of the station transmitter, and the data received was identified by the same data conditions code (DCC) 8150 used for one-way tracking. Reasonable parity error rates at 8 bits/s were obtained in this mode.

3. Dual maser configuration. On pass 686, a special R&D test was performed in an attempt to establish two-way lock on channel 7 by using a dual maser configuration. (This configuration had been used during the *Mariner V* Venus encounter.) For this experiment the two masers were used by DSS 14 as an R&D rotating linear feed. The signals were transmitted to the spacecraft, which radiated linearly polarized signals (Fig. 22). The masers, in effect, linearly summed the energy of the right circular polarization (RCP) and the left circular polarization (LCP). The resulting parity error rate and the received power were compared between receiver 1 (modified) and receiver 2 (standard) as follows:

Receiver	Signal level, dBmW	Bit rate, bits/s	Parity error rate
Modified	−159.9	16	0.039
Standard	−163.0	16	0.420
Standard	−162.9	8	0.07

The bit rate of a normal *Pioneer VI* track at that time was 8 bits/s, with a parity error rate of less than 0.1. With the modified receiver and a bit rate of 16 bits/s,

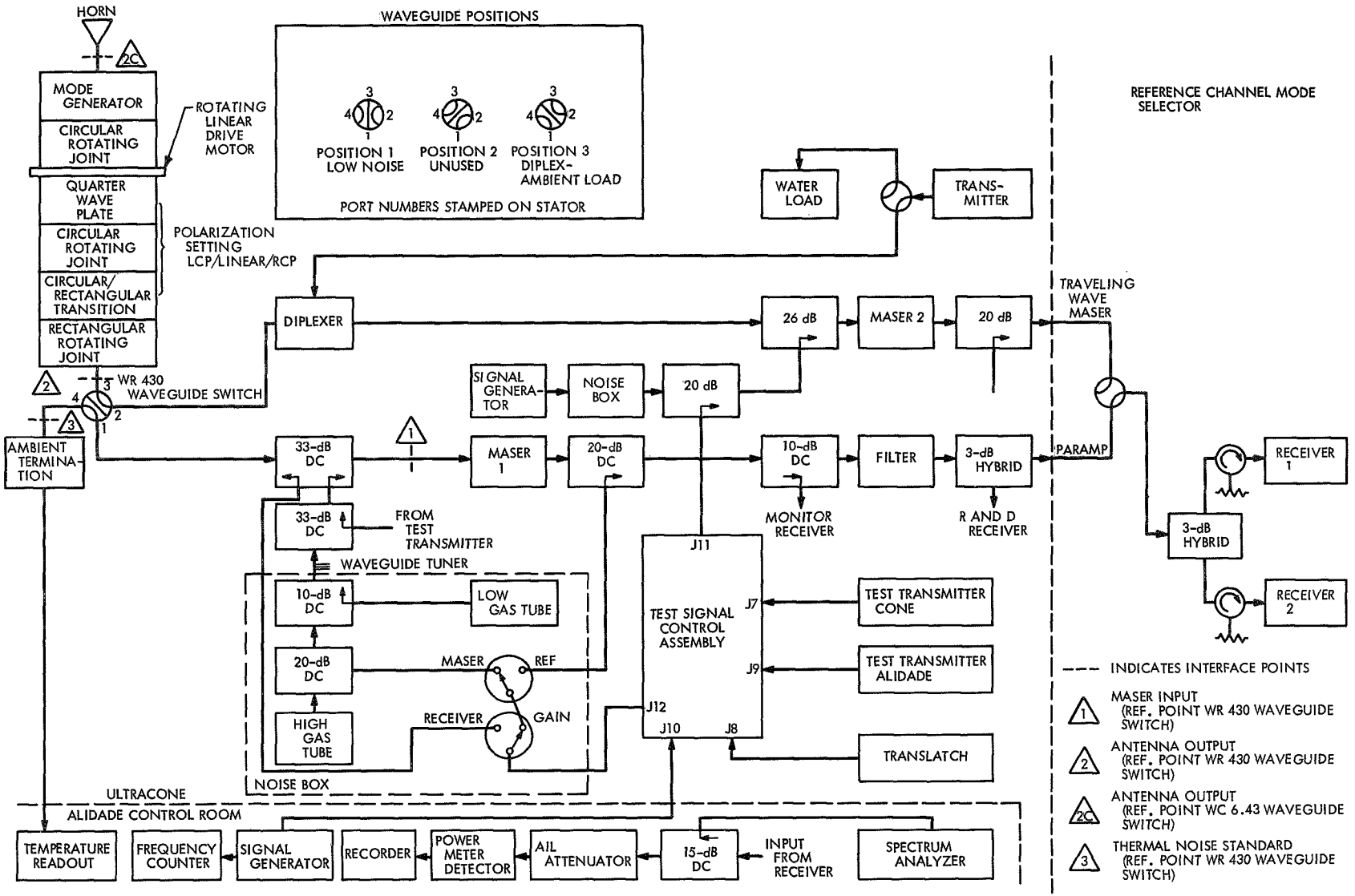

Fig. 20. Block diagram, S-band ultracone

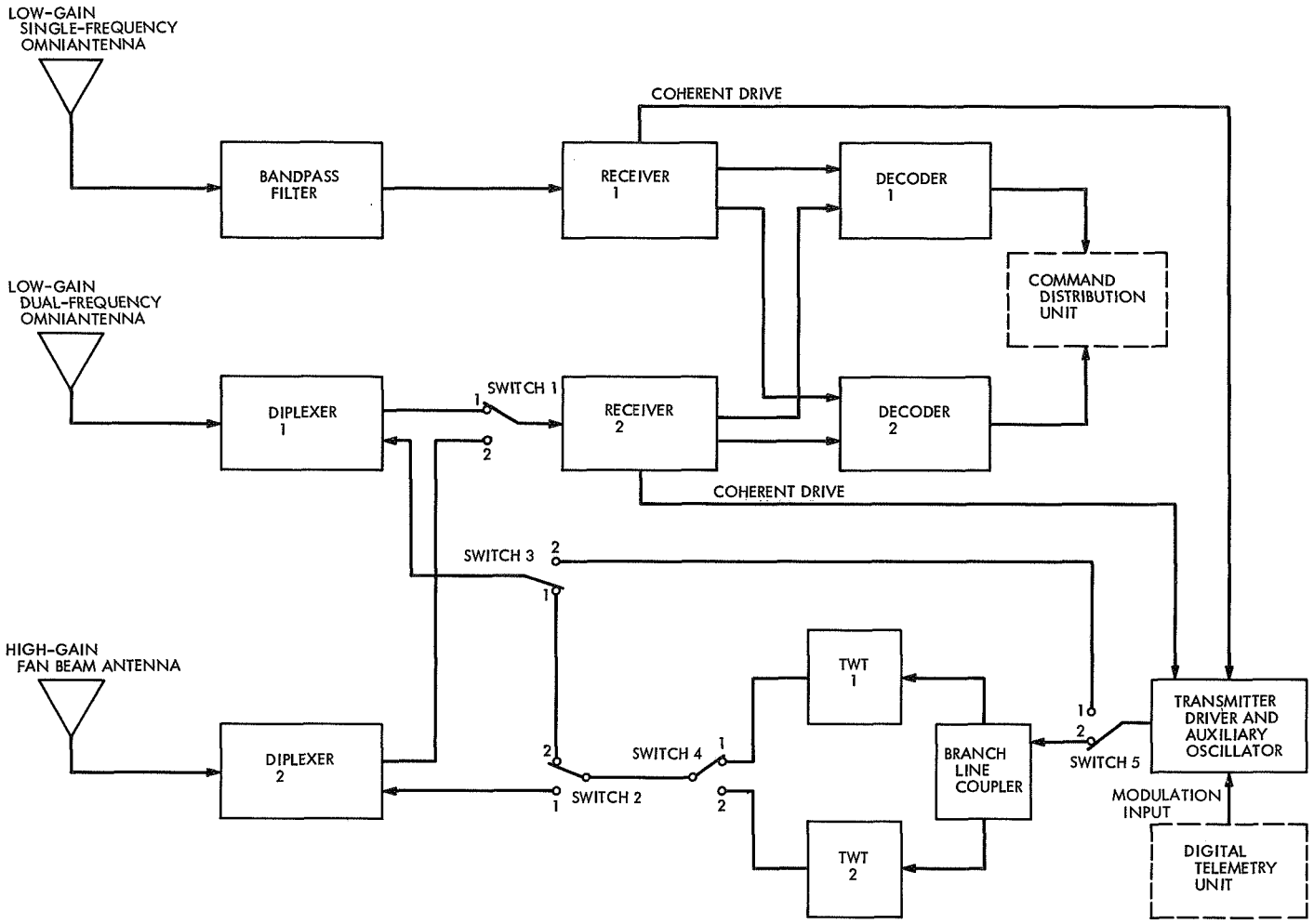

Fig. 21. Communications subsystem functional block diagram

the parity error was also less than 0.1, showing an increase of approximately 3 dBmW. The received signal level increased by 3 dBmW when switched between the standard and the modified receiver. However, the attempt to lock on channel 7 was unsuccessful, and although the configuration was switched back to channel 6 before the end of the pass, no good two-way data was obtained. All attempts to transmit commands then proved unsuccessful and the spacecraft was tracked in one-way mode only.

4. Ultracone configuration. Despite the spacecraft's great distance from earth, the ultracone provided tracking at a bit rate of 8 bits/s with low parity error rate readings. Handicaps were as follows: a spacecraft receiver problem prevented receipt of commands; the spacecraft duty cycle store was a fixed 16-bits/s operation. The normal procedure at DSS 14 was to go to duty cycle store mode at the end of a track, then to pick up the stored data at the beginning of the next track. The major difficulty was spacecraft reception of a command to change the 16-bits/s rate to a receivable 8-bits/s rate. The time spent in getting an acceptable command to the spacecraft caused the loss of considerable data.

The improved downlink signal strength (5 dBmW) gained from the ultracone made it possible to check the degree of malfunction in the spacecraft receiver 2. Beginning with pass 820, an attempt was made to lock in the spacecraft on channel 7 for two-way noncoherent tracking. Although there was intermittent success in locking in the receiver, attempts to get commands accepted failed. Apparently the receiver 2 malfunction had not lessened in degree. Telemetry was sent at fixed bit rate of 8 bits/s only, because of the marginal signal resulting from the spacecraft's distance from earth.

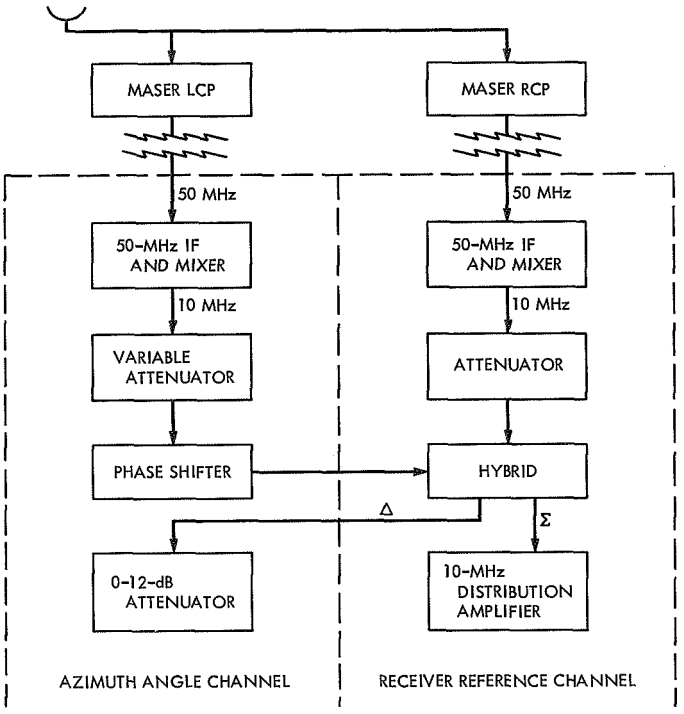

Fig. 22. Configuration of modified receiver in rotating linear feed experiment

C. Anomalies Related to Data Losses

Some instances of data losses and the anomalies that caused them during this report period are singled out here. The pass chronology contains additional information. On pass 581, 47 min of data was lost when the TCP was unable to lock at DSS 12; the spacecraft was in duty cycle store. On pass 584, the GOE at DSS 12 was unable to lock up the demodulator when the spacecraft was in one-way mode; 49 min of data was lost. Then, on pass 585, engineering data was missed at DSS 12 at the beginning of the pass; the telemetry was transmitted upon completion of the track.

A transmitter 400-Hz power failure caused a loss of data during some passes during January of 1968 (passes 747 through 777). The failure occurred when one of the two generators dropped off line; the load was too high for the other alone. As a result, the transmitter failed. On pass 852, 1 h 50 min of data was lost, and during passes 855 and 860 smaller amounts of data were lost. The losses occurred because the TCP program halted and had to be restarted many times in order to correct the data format. A bad connector was replaced.

A commercial power failure caused the loss of 1 h 35 min of data on pass 874. The power loss resulted from an overload relay in the 400-Hz motor-generator circuit. On pass 895, 15 min of data was lost when the antenna was positioned at zenith for signal variation check. No problem was discovered and the antenna was returned to spacecraft point without further incident. Tables 23, 24, and 25 present abbreviated telecommunication design control data for passes 591, 614, and 897.

D. RF Performance

1. Downlink. Table 26 presents receiver signal strength for passes 595 through 928. Figures 23 through 29 present predicted and actual downlink signal strength. Figure 30 shows predicted and actual signal strength vs time from launch. The downlink signal strength was within ±2 dBmW of the predicted signal strength in

Table 23. Abbreviated telecommunication design control, pass 591

No.	Parameter	Value	Tolerance, dB	
1	Total transmitting power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz; R = 2.38 × 10^8 km)	−267.2		
6	Polarization loss, 0.7 dB elliptical ratio	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61	+1.0	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−200	+2.4	−2.1
11	Total received power, dB	−161.6	+2.6	−2.3
12	Receiver noise spectral density (N/B), dBmW/Hz (temperature system = 29°K)	−184.1	+0.7	−0.9
13	Carrier modulation loss (θ = 0.9 ±5%), dB	−4.1	+0.5	−0.5
14	Received carrier power, dBmW	−165.7	+3.1	−2.8
15	Carrier APC noise BW ($2B_{LO}$ = 12 Hz), dB	10.8	+0.0	−0.5

Table 24. Abbreviated telecommunication design control, pass 614

No.	Parameter	Value	Tolerance, dB	
1	Total transmitter power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss (2292 MHz; $R = 2.4 \times 10^8$ km) (21 August 1967)	−267.2		
6	Polarization loss, dB	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft antenna), dB	61.8	+0.3	−0.3
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−199.2	+1.7	−1.9
11	Total received power, dBmW	−160.8	+1.9	−2.1
12	Carrier modulation loss ($0 = 0.9 \pm 5\%$), dB	−4.1	+0.5	−0.5
13	Received carrier power, dBmW	−164.9	+2.4	−2.6

most cases throughout July, August, and September of 1967. The margin was 2.5 dBmW for the only five passes in October. For the remainder of 1967, the received signal strength values increased ±3 dBmW. This increase apparently resulted from the dual maser installation at DSS 14.

During January and February of 1968, the data was plotted from telemetry clusters in two groups: one roughly 3 dBmW above the predicted curve and the other roughly 5 dBmW above (Fig. 30). The 3-dBmW increment was credited to the dual-maser configuration as in the previous period. The 5 dBmW resulted from a 2-dBmW error communicated to the network and originating in a calculation of line-loss between the maser and the receiver in the control building.

During March and April the predicted signal strength was exceeded by 5 dBmW and 4 dBmW, respectively; the improvement was attributed to the new ultracone configuration. The strength was fairly close to the predicted curve with the linear to circular polarizer operating during May. During June, the polarizer was on and the diplexer was bypassed to provide an optimum downlink signal. Good data was obtained during 98.6% of the tracking time.

Table 25. Abbreviated telecommunication design control, pass 897

No.	Parameter	Value, dB	Tolerance, dB	
1	Total transmitter power, dBmW	38.4	0.2	−0.2
2	Transmitting circuit loss, dB	1.4	0.5	−0.6
3	Transmitting antenna gain, dB	11.0	0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz; $R = 2.91 \times 10^8$ km)	268.9		
6[a]	Polarization loss, dB	3.0 or 0	0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61.8	0.5	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	0.2	0.1	−0.1
10[a]	Net circuit loss, dB	200.7 or 197.7	1.9	−2.0
11[a]	Total received power, dB	−162.3 or 159.3	2.1	−2.2
12	Receiver noise spectral density (N/B) (temperature system = 19°K, listen only), dBmW	185.8	0.7	−0.9
13	Carrier modulation loss ($\theta = 0.9 \pm 5\%$), dB	4.1	0.5	−0.5
14[a]	Received carrier power, dBmW	−166.4 or 163.4	2.6	−2.7
15	Carrier APC noise BW ($2B_{LO} = 12$ Hz), dB	10.8	0.0	−0.5
16	Measured carrier power, dBmW	−163.5		
17	Calculated (14), measured (16) with polarized unit installed, dB	−0.1		

[a]Circular or linear configuration

Table 26. Summary of Operations, Passes 595–928

Pass No	DSS No	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
595	14	214	1528	1909				-165.5	12	29.7 N/A	-174 N/A	7	.040 .812	8 16	
597	14	216	1043 1121	1401	1043 1121	1122 1401	---	-165.6	12	28.9 28.9	-175 -175	5	.030	8	
599	14	218	1044 1124	1930	1044 1124	1124 1930		-166	12	28.2	-174	8	.150	8	
600	14	219	1044 1124	2200	1044 1124	1124 2157	---	-165.8	12	28.3 30.0	-174 -175	17	.050	8	
601	14	220	1045	1900	1045 1127	1128 1900		-165.9	12	28.8	-175	13	.210	8	Record only from 1443 to 1550 due to TCP Bravo failure. TFR 12-TCP-103242. Computer Alpha not available.
602	14	221	1534	1902	1534 1618	1618 1902		-165.8	12	28.7	-174	7	.110	8	
604	14	223	1123	1425	1122 1210	1210 1425	---	-165.7	12	28.3 29.2	-174 -174	7	.200	8 16	
605	14	224	1048	1401	1048 1150	1151 1401	---	-166.0	12	29.3 29.6	-174 -175	9	.400	8 16	
608	14	227	1048	1604	1048 1136	1137 1604	---	-165.5	12	30.2 30.5	-174 -174	9	.400	16 8	TCP had a program failure. TFR 12-TCP-100418. Command 3/053 not enabled due to TCP failure. Command retransmitted when TCP restart was successful. Data lost will be reported in monthly report.
611	14	230	1122	1604	1122 1204	1215 1604	---	-166	12	28.3 28.2	-174 -174	9	.090	8	
613	14	232	1103	1930	1103 1154	1200 1930	---	-165.5	12	29.7	-169	8	.200	8 16	Antenna in prelimit - TFR 10021. Master Equatorial was driven in the wrong direction for acquisition during precals. The M. E. was returned to correct position.
614	14	233	1052	1853	1052 1336	1138 1853	---	-164	12	30.0	-169	13	.150	8 16	TCP and GOE lost lock at MMSA due to loss of TLM from DSS 14. DSS 14 discovered bad AIS patch cord.
616	14	235	1504	1920	1504 1552	1552 1920	---	-166	12	31.4 30.2	-174 -174	9	.400	16	Retuned transmitter. Microwave outage caused loss of command capability at 15552. COMM restored. TFR is 103943. TCP lost W/F sync for 45 seconds. Playback of tape indicates a short loss of TLM due to microwave outage.
618	14	237	1058	1400	1058 1144	1146 1400	---	-165.5	12	28.6 28.6	-169	8	.200	8 16	
620	14	239	1055	2159	1055 1138	1138 2159		-166.1	12	27.7 27.6	-175 -175	193	.200	8 16	Type I orientation.
621	14	240	1159	1928	1159 1244	1244 1928		-165.3	12	27.9 N/A	-169 N/A	13	.050	8	
623	14	242	1134	1847	1134 1218	1218 1847	---	-164.9	12	28.2 N/A	-175 N/A	14	.080	8 16	At 1633Z the antenna lost S/C signal due to pointing errors. TFR 14 ADS-100212. Problem was in the Azimuth Channel of the Auto-Collimator of the Master Equatorial.
625	14	244	1125	1600	1125 1209	1209 1600	---	-165.3	12	28.6 28.8	-174 -174	11	.100	8 16	
626	14	245	1420	1904	1420 1504	1505 1904	---	-165	12	31.5 N/A	-174 N/A	9	.060	8 16	
627	14	246	1120	1401	1120 1208	1209 1401	---	-165.8	12	28.6 28.8	-174 -174	4	.070	16	
628	14	247	1100	1859	1100 1141	1141 1859	---	-165.7	12	28.2 N/A	-175 N/A	10	.070	8 16	
629	14	248	1110	1441	1110 1151	1151 1441	---	-165.5	12	28.3 N/A	-174 N/A	8	.035	8	
634	14	253	1112	1431	1112 1213	1214 1431	---	-165.3	12	28.7 28.5	-174 -175	5	---	8 16	PER: 1157 - Bad 1231 - Bad 1415 - .022 Went 8 bps at 1245
635	14	254	1212	1559	1212 1302	1303 1559	---	-165.4	12	28.7 29.6	-174 -175	7	.000 .713	8 16	
638	14	257	1118	2201	1118 1212	1213 2201	---	-163.3	12	29.5 28.1	-174 -175	11	.025	8	At 1625 DIS Input TTY failed. IMP stopped at 1628. DIS input TTY replaced with spare-IMP started. TFR 14-101586. At 1628 REC B went to stop mode: Relay K-10 was replaced.
641	14	260	1112	1943	1112 1203	1205 1943		-164.5	12	29.1	-174	10	.070	8	

Table 26 (contd)

Pass No	DSS No	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
646	14	265	1132	2000	1132 1224 1639 1823	1230 1638 1824 2000	--- ---	-165.5	12	29.7 N/A	-174 N/A	11	.200	8	At 1612 TXR kicked off. H.V. cable feeding Klystron was arcing. Cable repaired.
648	14	267	118	2001	1118 1216 1542 1615	1217 1541 1616 2001	--- ---	-165.5	12	28.2	-174	7	.230	8	At 1242 DIS TTY IMP failed. TFR 14-DIS-101531. At 1252 TTY changed - IMP became operational. At 1541 RCV dropped lock due to beam current overload kicked off on Klystron power supply. No reason for drop out. Retuned and checked gain. Error rate abnormally high for reported signal strength. Klystron creating noise problem during pass. Subsequently corrected.
675	14	294	1547	2128	1547 1636	1639 2128		-163.3	12	28.0	-173	7	.080	8	Lost W/F sync throughout pass. TCP or GOE problem - not known. TXR power increased to 15KW for command transmission. Replaced computer buffer to correct W/F sync-investigating command problem.
677	14	296	1144	2257	1144 1220	1233 2257		-163.3	12	28.7	-172	10	.080	8	Numerous loss of W/F sync at stations 12/14 - trouble shooting problem. TXR power to 20KW for command transmission. Replaced computer buffer to correct W/F sync-investigating command problem.
678	14	297	1253	2257	1253 1330	1334 2257		-163.3	12			23	.100	8	Although 23 commands were transmitted to S/C, not all commands were effective. Net control reporting does not reflect which commands were effective. TCP in and out of lock many times throughout pass.
683	14	302	1654	2252	1654 2042	2042 2252		-164.3	12	27.7	-173	5	N/A		Unable to establish uplink on channel 7, believed to be spacecraft anomaly.
684	14	303	1152	2132	1152 1351	1357 2132		-163.7	12	27.8	-173	11	.032	8	Unable to establish uplink on channel 7.
686	14	305	1155	2248	1155 2248			+62.6	12	27.4	-173	0	0.200	16	Unable to establish uplink on Channel 7.
688	14	307	1159	1800	1159 1244	1246 1800		-163.5	12	28.2	-173	4	Bad	8	Frequent receiver glitches caused bad PER. Probably due to S/C anomaly.
689	14	308	1159	2244	1159 1340 2115 2244	1342 1624 1626 2115 Non-coherent		-163.6	12	28.3	-172	18	Bad 0.090	8 8	Bad PER in both one-way and two-way coherent modes as result of receiver glitches. Upon going noncoherent, glitches stopped and PER became good. Analyzed by ARC as S/C problem. SDA reported that SPE was fluctuating from 5 kHz to 20 kHz indicating that Receiver No. 2 was oscillating.
691	14	310	1214	2242	1214 1932	1932 2242 Non-coherent		-163.1	12	27.8	-173	13	0.038	8	Two commands were not sent as a result of microwave line mismatch between DSS 12 and 14. Project reported that none of the 13 commands were received by the S/C.
693	14	312	1203	2128	1203 1819	1819 2128 Non-coherent		-162.7	12	28.2	-173	13	0.090	8	None of the commands were received by the S/C as a result of S/C anomaly.
695	14	314	1206	2101	1206 1340	1340 2101 Non-coherent		+62.7	12	26.9	-172	0	0.076	8	SDA signal strength appeared to be 2.5 dbm better than theoretically predicted.
700	14	319	1212	2015	1212 1315	1315 2015 Non-coherent		-162.7	12	30	-173	0	0.038	8	
701	14	320	1214	2100	1214 1316	1316 2100 Non-coherent		-162.8	12	27.8	-173	1	0.039	8	
703	14	322	1216	2000	1216 1300	1300 2000 Non-coherent		-163.5	12	27.8	-173	0	0.050	8	
705	14	324	1219	2000	1219 1300	1300 2000 Non-coherent		-163.1	12	28	-171	0	0.041	8	

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time			Signal Strength Avg (dbm)	Configuration			No. of Cmds	Average PER	Bit Rate	Comments
					1-Way	2-Way	3-Way		Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)				
707	14	326	1230	1500	1230 1315	1315 1500 Non-coherent									
709	14	328	1323	1935	1329 1420	1420 1935 Non-coherent		-162.6	12	28.3	-173	0	0.039	8	Unable to obtain stable DSIF transmitter output above 10 kw.
712	14	331	1230	1845	1230 1348	1348 1845 Non-coherent		-163.6	12	28	-172	0	0.099	8	
714	14	333	1234	1945	1234 1335	1335 1945 Non-coherent		-162.8	12	27.4	-173	0	0.110	8	
715	14	334	1235	1500	1235 1330	1330 1500 Non-coherent		-162.9	12	27.9	-173	0	0.079	8	
718	14	337	1250	2000	1250 2000			-162.7	12	28.2	-173	0			Record only pass.
721	14	340	1250	1600	1250 1448	1449 1600		-163.4	12	28.8	-173	0	0.070	8	
724	14	343	1251	1908	1251 1358	1400 1908		-163	12	27.8	-171	0	0.029	8	Noncoherent tracking mode.
725	14	344	1253	1930	1253 1350	1354 1930		-163	12	26.3	-172	0	0.062	8	Noncoherent tracking mode.
726	14	345	1255	1601	1255 1345	1347 1601		-162.6	12	27.2	-173	0	0.080	8	Noncoherent tracking mode.
727	14	346	1259	1501	1259 1408	1410 1501		-163	12	28.3	-172	0	0.080	8	Noncoherent tracking mode.
732	14	351	1305	2001	1305 2001			-163.7	12	28.2	-173	0	N/A	N/A	Record only.
734	14	353	1309	2001	1309 1340	1340 2001 Non-coherent		-163.5	12	27.5	-172	0	0.076	8	
736	14	355	1313	1500	1313 1500			-163.7	12	27.2	-172	0	0.100	8	
738	14	357	1316	1500	1316 1500			-164.0	12	27.6	-173	0	0.100	8	
739	14	358	1451	2000	1451 2000			-163.7	12	None	None	None	0.100	8	
741	14	360	1322	1500	1322 1500			-163.5	12	28.3	-173		0.180	8	
742	14	361	1323	1500	1323 1500			-163.4	12	28.1	-173		0.170	8	
743	14	362	1325	1505	1325 1505			-163.3	12	28.8	-172		0.150	8	
747	14	001	1336	1511	1336 1511			-162.9	12	27.4	-172	0			
748	14	002	1335	1500	1335 1500			-162.8	12	28.5	-172	0			
749	14	003	1336	1512	1336 1512			-163.3	12	27.6	-172	0			
750	14	004	1337	1514	1337 1514			-163.3	12	27.6	-174	0	0.300	8	
751	14	005	1705	2000	1705 2000			-163.7	12	27.9	-173	0	0.142	8	
752	14	006	1342	1951	1342 1951			-164.2	12	26.9	-173	0	0.177	8	
756	14	010	1348	1501	1348 1501			-163.5	12	27.6	-173	0	0.500	8	
757	14	011	1349	1501	1349 1501			-164	12	28.8	-171	0	0.268	8	
758	14	012	1350	1500	1350 1500			-164.1	12	27.6	-173		0.383	8	

N/A Not Applicable
Times are given in Greenwich Mean Time

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
759	14	013	1351	2001	1351 2001			-163.9	12	N/A	N/A		0.153	8	LC unless indicated.
760	14	015	1725	2001	1725 2001			-163.4	12	26.8	-173		0.250	8	Unable to monitor AGC volts for RCV 1. RCV 2 was used as prime. Replaced RCV 1 AGC amplifier and filter.
762	14	016	1355	1500	1355 1500			-164.1	12	27.2	-173		0.576	8	
763	14	017	1356	1500	1356 1500			-164.3	12	28.3	-173		0.500	8	
765	14	019	1454	2200	1454 1600	1600 2200		-165.4	12	27.9	-173	4	0.150	8	LC unless indicated.
766	14	020	1400	2000	1400 1405	1405 2000		-164.9	12	28.5	-173	3	0.273	8	At 1450 bad patch on science data line through Comm; no data lost.
767	14	021	1723	2000	1723 1803	1803 2000		-163.5	12	28.5	-173	2	0.100	8	
768	14	022	1602	1840	1602 1840			-163.7	12	28.0	-173	0	0.230	8	Unable to acquire S/C uplink; reason unknown
769	14	023	1604	1840	1604 1703	1703 1840		-163.6	12	28.1	-173	2	0.300	8	
771	14	025	1800	2000	1800 1849	1849 2000		-161.5	12	28.9	-173	2	0.020	8	Dual maser operation improved parity error.
772	14	026	1752	2000	1752 1810	1810 2000		-161.1	12	28.3	-173	2	0.000	8	
773	14	027	1405	2015	1405 2015			-161.2	12	29	-173	2	0.040	8	LC unless indicated.
774	14	028	1759	2000	1759 2000			-165.2	12	27.8	-174	0	0.210	8	Dual maser inoperative. TFR 105305. TXR 400 cycle failed prior to pass due to power fluctuations. TFR 105304. Data not affected.
775	14	029	1406	1845	1406 1845			-164.4	12	28	-173	3	0.210	8	
776	14	030	1408	1830	1408 1830			-163.5	12			2	0.318	8	No pretrack or post track calibrations, noncoherent mode.
777	14	031	1408	1830	1408 1830			-161.4	12	28.2	-173	2	0.030	8	
786	14	040	1700	2000	1700 1752	*1752 2000		-161.2	12	28.7	-173	2	0.030	8	*Spacecraft noncoherent mode.
787	14	041	1417	2000	1417 1557	*1557 2000		-161.3	12	35.2	-172	4	0.040	8	*Spacecraft nonchoerent mode.
788	14	042	1513	2001	1815 1909	*1909 2001		-161.2	12	28.5	-172	0	0.000	8	Spacecraft noncoherent mode at 1610. Loss of commercial power delayed acquisition. Parity error of 0.000 based on one reading.
789	14	043	1615	1900	1615 1706	*1706 1900		-161.9	12	28.0	-173	2	0.120	8	*Spacecraft noncoherent mode.
790	14	044	1614	1900	1614 1722	*1722 1900		-161.5	12	27.2	-173	2	0.050	8	*Spacecraft noncoherent mode.
791	14	045	1624	1900	1624 1716	*1716 1900		-161.5	12	28.5	-173	4	0.110	8	*Spacecraft noncoherent mode. 400-cycle power failure from 1545 to 1633. No data lost.
792	14	046	1612	1900	1612 1648	*1648 1900		-163.3	12	28.5	-172	4	0.480	8	*Spacecraft noncoherent mode. Spacecraft agc incorrect at 1720 due to faulty prepass instructions. Prepass instructions read T2 R2 instead T1 R1 in dual Maser configuration.
794	14	048	1602	1900	1602 1722	*1722 1900		-164.3	12	26.9	-174	4	Bad	8	Maser 2 inoperative. No linear polarization mode. *Noncoherent.
795	14	049	1542	1900	1542	*1751 1900		-165.0	12	29.0	-174	3	Bad	8/16	Maser 2 inoperative. No linear polarization mode. *Noncoherent.
798	14	052	1556	1900	1556 1702	*1702 1900		-162.0	12	27.6	-173	4	0.500	8	Dual Maser configuration. *Spacecraft in noncoherent mode.
799	14	053	1733	1930	1733 1740	*1740 1930		-164.8	12	29.2	-173	2	Bad	8	Maser 2 inoperative. No linear polarization mode. *Spacecraft in noncoherent mode.
801	14	055	1530	1900	1530 1742	*1742 1900		-162	12	26.7	-174	2	0.000/ 0.460	8	Dual Maser linear configuration. *Noncoherent mode.

*Noncoherent Mode

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
802	14	056	1541	1900	1541 1700	*1700 1900		-161.2	12	26.6	-173	4	0.000/ 0.110	8	Dual Maser linear configuration. *Noncoherent mode.
804	14	058	1544	1900	1544 1731	*1731 1900		-164.2	12	27.4	-174	2	0.653/ 0.919	8	*Noncoherent mode, standard configuration. Maser 2 down.
805	14	059	1554	1900	1554 1750	*1750 1900		-161.4	12	26.8	-173	2	0.000/ 0.291	8	*Noncoherent mode. Dual Maser linear configuration.
806	14	060	1542	1900	1542 1704 1710 1840	*1704 1710 *1840 1900		-161.2	12	27.6	-173	0	0.038/ 0.191	8	*Noncoherent mode. Dual Maser linear configuration. 171002 TXR off due to TXR beam overcurrent.
807	14	061	1621	1900	1621 1735	*1735 1900		-161.0	12	27.5	-173	2	0.060	8	Dual maser configuration from 1625.
808	14	062	1616	1900	1616 1728	*1728 1900		-161.2	12	27.8	-172	2	0.150	8	Dual maser configuration.
809	14	063	1621	1900	1621 1725	*1725 1900		-161.7	12	27.4	-173	4	0.038	8	Dual maser configuration.
812	14	066	1726	2000	1726 2000			-161	12	18.6		0	0.000	8	Station was advised to track S/C due to a Class 3 solar flare. TXR down. Kicking interlocks.
813	14	067	1456	2000	1456 2000			No AGC Curve	12			0	0.000 0.039	8	Transmitter off due to arcing in 400-cycle motor generator. 184500 - 2245. Communication cable cut by construction equipment; lost all communications. Maser 1 down.
814	14	068	1417	2000	1417 2000			-161.7	12	31.6	-172	0	0.010	8	At 1300, 400-cycle power failed. Power on again at 1328. This track had numerous problems with power.
815	14	069	1718	2000	1718 2000			-162.6	12	20.8	-173	0	0.010	8	Ultracone mode. Linear polarization.
816	14	070	1707	2000	1707 2000			-161.5	12	21.0	-173	0	0.000	8	Linear diplexer configuration. No uplink indication.
817	14	071	1515	1900	1515 1900			-161.8	12	21.1	-173	4	0.030	8	Linear diplexer configuration. No uplink indications.
818	14	072	1528	1900	1528 1900			-162.0	12	20.9	-173	2	0.012	8	At 1605, Demod will not lock up. Brought up station 12 to support TLM for Pass 818 and Pioneer VII, Pass 574. At 184310, TXR off. Lost 400-cycle fan in power support. Jumpered around interlock for Pioneer VII pass. TFR 105335. No uplink indications. Linear diplexer configuration.
819	14	073	1523	1900	1523 1900			-161.9	12	28.8	-173	0	0.000	8	Linear diplexer configuration. At 164800, TXR power dropped to 8 kw due to problem with motor-driven attenuator. At 1703, the transmitter (XMTR) went off. DSS 12 provided TLM support.
820	14	074	1514	1910	1514 1815	**1815 1910		-161.9	12	29.9	-173	2	0.000	8	Linear diplexer configuration.
822	14	076	1532	1900	1532 1900	*	*	-162.0	12	30.2	-172	2*	0.000	8	Commands sent with no uplink indication.
823	14	077	1503	1900	1503 1603	**1603 1900		-161.0	12	28.7	-173	6	0.000	8	Linear diplexer feed.
824	14	078	1507	2000	1507 1853	**1853 2000		-161.5	12	28.7	-173	4	0.000	8	Linear diplexer feed.
825	14	079	1520	1903	1520 1903			-160.8	12	29.6	-172	2*	0.000	8	Commands sent with no uplink indication.
826	14	080	1457	1900	1457 1711	†1711 1900		-163.5	12	29.9	-173	6	0.691	8	RCP diplexer configuration.
827	14	081	1445	1900	1445 1900			-161.0	12	30.1	-172	0	0.000	8	Linear diplexer feed. At 165230, antenna was placed in the brake mode for 2 minutes due to an unauthorized crane in the area.
829	14	083	1523	2000	1523 1641 1732 1845	***1641 1732 1845 2000		-161.5	12	28.2	-173	4	0.000	8	At 1619, bad card found in doppler counter. At 1641, XMTR power unstable to end of track. Cable arcing. At 1802, station time was found off by + 2 seconds.
830	14	084	1459	2000	1459 1720	***1720 2000		-161.7	12	29.0	-173	8	0.000	8	

* One way only.
** Two-way noncoherent Channel 7.
*** Noncoherent mode Channel 7.
† Two-way noncoherent Channel 6.

*Noncoherent mode
Note: Unless otherwise indicated, all times are GMT.

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time			Signal Strength Avg (dbm)	Configuration			No. of Cmds	Average PER	Bit Rate	Comments
					1-Way	2-Way	3-Way		Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)				
831	14	085	1457	2030	1457 1928 1959 2030	*1928 1959		-160.9	12	29.3	-173	6	0.038	8	P1/W0/B12 from 1457 to 2030.
832	14	086	1455	1900	1455 1553 1726 1900	*1553 1726		-161.4	12	29.2	-173	4	0.039	8	P1/W0/B12 from 1455 to 1900.
833	14	087	1448	1900	1448 1900			-163	12	28.6	-173	0	0.038	8	P1/W0/B12 from 1448 to 1900. 1. At 1519 TDH doppler resolver counter bad. 2. Doppler data bad from 1715 to 1805. 3. At 171930, XMTR off due to overbody current until remainder of pass.
834	14	088	1453	1900	1453 1808 1856 1900	*1808 1856		-163	12	28.4	-173	2	0.000	8	P1/W0/B12 from 1453 to 1900. At 171900, XMTR output power appeared unstable. Problem in instrumentation only.
835	14	089	2117	0028	2117 0028			-162.5	12	30.6	-174	0	0.076	8	P1/D1/B12 from 2117 to 0028.
836	14	090	1451	2000	*1451 2000			-163	12	29.0	-173	2	0.076	8	P1/W0/B12 from 1451 to 2000.
837	14	091	1441	2000	*1441 2000			-163.2	12	30	-173	2		8	P1/D1/B12 from 1441 to 2000.
838	14	092	1455	2000	1455 2000			-162.7	12	30	-173	0	0.000	8	P1/D1/B12; from 1455 to 1639 P1/D0/B12; from 1639 to 2000
839	14	093	1456	1900	1456 1900			-162.9	12	49.5	-175	0	0.000	8	P1/D0/B12; from 1458 to 164733 P1/D1/B12; from 164733 to 1900 Maser 1 failed at 164733. Switched to Maser 2 (TFR 105358) 1700; doppler resolver not operating properly (TFR 105359).
840	14	094	1459	1900	1459 1900			-162.9	12	28.7	-173	0	0.000	8	P1/D1/B12; from 1459 to 1900 Maser 1 down at start of pass. ERN as of 094/1530.
841	14	095	1446	1900	1446 1900			-162.9	12	18.75	-175	0	0.000	8	P1/D0/B12; from 1446 to 1900.
843	14	097	1330	2000	1330 2000			-163.2	12	23.4	-175	0	0.000	8	P1/D0/B12.
844	14	098	1329	2000	1329 2000			-163.2	12	22.0	-175	0	0.000	8	P1/D0/B12.
845	14	099	1419	2000	1419 2000			-162.2	12	22.4	-175	0	0.020	8	Landline link cable cut at Station 1730. Record-only to end of track.
846	14	100	1352	1900	1352 1900			-163.4	12	22.3	-176	0	0.000	8	P1/D0/B12.
847	14	101	1417	1900	1417 1900			-163	12	29.8	-174	0	0.000	8	P1/D1/B12; from 1417 to 1427. P1/D0/B12; from 1427 to 1900.
848	14	102	1345	1900	1345 1900			-163.3	12	16.7	-176	0	0.000	8	P1/D0/B12.
850	14	104	1335	2000	1335 2000			-163.1	12	19.7	-176	0	0.000	8	P1/D0/B12; from 1335 to 2000.
851	14	105	1343	2000	1343 2000			-163.6	12	18.4	-176	0	0.000	8	P1/D0/B12; from 1343 to 2000.
852	14	106	1639	2200	1639 2200			-163.2	12	19.9	-176	0	0.000	8	P1/D0/B12; from 1639 to 2200. Demod bad from 1639 to 1908. Changed at 1908 with Demod scheduled for shipment to DSS 42.
853	14	107	1657	2000	1657 2000			-163.6	12	19.7	-176	0	0.000	8	P1/D0/B12; from 1657 to 2000.
854	14	108	1312	1900	1312 1900			-163	12	20	-175	0	0.000	8	P1/D0/B12; from 1312 to 1900. Signal strength low at acquisition. Off S/C at 1323 to make checks. At 1341 back on S/C with normal signal level. Test transmitter switched out and problem cleared.
855	14	109	1310	1923	1310 1923			-163.3	12	29.6	-174	0	0.076	8	At 1338, switched to Maser 2 since the signal level was 3 db low on Maser 1. 1342 - 1720 (TCP) restarted several times due to bad science data; cause unknown. P1/D0/B12 from 1310 to 1327. P1/D0/B12 from 1327 to 1329. P1/D0/B12 from 1329 to 1338. P1/D1/B12 from 1338 to 1923.
859	14	113	1956	0055	1956			-162.7	12	19.8	-176	0	0.000	8	P1/D0/B12 from 1955 to 0055. Several TCP failures.

*Noncoherent mode Channel 7.

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
860	14	114	1515	1900	1515 1900			-163.3	12	18.4	-174	0	0.000	8	P1/D0/B12 from 1515 to 1900. TCP program hung up several times.
861	14	115	1520	1900	1520 1900			-163.2	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1520 to 1900. 153500 TCP halted; reason unknown.
862	14	116	1321	2200	1321 2200			-163.4	12	18.4	-175	0	0.000	8	P1/D0/B12 from 1321 to 2200.
864	14	118	1328	2200	1328 2200			-163.5	12	20.0	-175	0	0.000	8	P1/D0/B12 from 1328 to 2200.
865	14	119	1321	2200	1321 2200			-163.8	12	20.9	-175	0	0.038	8	P1/D0/B12 from 1321 to 2200.
866	14	120	1415	1930	1415 1930			-163.3	12	20.1	-175	0	0.000	8	P1/D0/B12 from 1415 to 1930.
867	14	121	1323	1700	1323 1700			-163.4	12	17.7	-175	0	0.000	8	P1/D0/B12 from 1323 to 1930.
869	14	123	1318	1700	1318 1700			-163.3	12	18.2	-175	0	0.000	8	P1/D0/B12 from 1318 to 1700.
871	14	125	1252	1730	1252 1730			-164.4	12	19.3	-176	0	0.000	8	P1/D0/B12 from 1252 to 1730.
872	14	126	1251	2000	1251 2000			-163.9	12	18.6	-175	0	0.000	8	P1/D0/B12 from 1251 to 2000.
873	14	127	1253	1700	1253 1700			-163.9	12	18.5	-176	0	0.000	8	P1/D0/B12 from 1253 to 1700.
874	14	128	1258	1700	1258 1344 1517 1700			-163.7	12	19.2	-176	0	0.000	8	P1/D0/B12 from 1258 to 1700. At 1345, the commercial power failed and came back on again at 1346. At 1512, the 400-cycle motor-generator sets came back on; continued track.
875	14	129	1248	1700	1248 1700			-163.5	12	18.6	-176	0	0.000	8	P1/D0/B12 from 1248 to 1700.
877	14	131	1246	1700	1246 1700			-164.4	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1246 to 1700. From 1250 through 1606, the engineering and science data garbled; readjusted current level out of comm buffer
878	14	132	1245	1700	1245 1700			-163.8	12	19.3	-176	0	0.000	8	P1/D0/B12 from 1245 to 1700.
879	14	133	1244	1700	1244 1700			-164	12	18.2	-176	0	0.038	8	P1/D0/B12 from 1244 to 1700.
880	14	134	1245	1700	1245 1700			-163.4	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1245 to 1700.
881	14	135	1258	1700	1258 1700			-163.4	12	18.6	-176.2	0	0.000	8	P1/D0/B12 from 1258 to 1700.
882	14	136	1247	1700	1247 1700			-164	12	18.7	-176	0	0.000	8	P1/D0/B12 from 1247 to 1700.
883	14	137	1241	1700	1241 1700			-163.2	12	19.0	-176	0	0.000	8	P1/D0/B12 from 1241 to 1700.
885	14	139	1239	1700	1239 1700			-163.4	12	16.7	-176	0	0.000	8	P1/D0/B12 from 1239 to 1700.
886	14	140	1238	1700	1238 1700			-164	12	17	-176	0	0.000	8	P1/D0/B12 from 1238 to 1700.
887	14	141	1238	1700	1238 1700			-163.3	12	17	-176	0	0.000	8	P1/D0/B12 from 1238 to 1700.
888	14	142	1237	1700	1237 1700			-163.5	12	16.2	-176	0	0.000	8	P1/D0/B12 from 1237 to 1700.
889	14	143	1237	1700	1237 1700			-163.6	12	16.6	-176	0	0.000	8	P1/D0/B12 from 1237 to 1700. At 1233, the master equatorial torquer failed, switched antenna to Precision Mode 2.
891	14	145	1239	1700	1239 1700			-164.3	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1239 to 1700.
892	14	146	1234	1700	1234 1700			-163.8	12	17.2	-176	0	0.000	8	P1/D0/B12 from 1234 to 1700.
893	14	147	1233	1700	1233 1700			-163.7	12	19.6	-176	0	0.000	8	P1/D0/B12 from 1233 to 1700.
894	14	148	1233	1630	1233 1630			-163.5	12	17.4	-176	0	0.000	8	P1/D0/B12 from 1233 to 1630

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
895	14	149	1232	1700	1232 1700			-163.5	12	18.3	-176	0	0.083	8	P1/D0/B12 from 1232 to 1318, P1/D1/B12 from 1318 to 1623, and P1/D0/B12 from 1623 to 1700. Excessive parity error rate. Antenna was positioned off point at 1343 to trouble-shoot; back on point at 1358 — no problem found.
896	14	150	1258	1730	1258 1730			-163.4	12	18	-176	0	0.000	8	P1/D0/B12 from 1258 to 1730
897	14	151	1406 1730	1730	1406			-163.5	12	17.1	-176	0	0.076	8	P1/D0/B12 from 1406 to 1730.
899	14	153	1251	1730	1251 1730			-163.7	12	17.6	-176		0.000	8	P1/D0/B12 from 1251 to 1730.
900	14	154	1245	1730	1245 1730			-163.6	12	18.4	-176		0.000	8	P1/D0/B12 from 1245 to 1730.
901	14	155	1229	1600	1229 1600			-163.2	12	17.7	-176		0.000	8	P1/D0/B12 from 1229 to 1600.
902	14	156	1232	1700	1232 1700			-164.1	12	18.2	-176		0.000	8	P1/D0/B12 from 1232 to 1700.
903	14	157	1228	1700	1228 1700			-163.3	12	19.4	-176		0.000	8	P1/D0/B12 from 1228 to 1700.
904	14	158	1227	1700	1228 1700			-164.4	12	18.5	-176		0.000	8	P1/D0/B12 from 1227 to 1700.
906	14	160	1227	1700	1227 1700			-163.2	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1227 to 1700. TXR down.
907	14	161	1226	1700	1226 1700			-163.8	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1226 to 1700.
908	14	162	1227	1630	1227 1630			-163.7	12	18.6	-176	0	0.000	8	P1/D0/B12 from 1227 to 1630.
909	14	163	1226	1730	1226 1730			-163.5	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1226 to 1730.
910	14	164	1438	1830	1438 1830			-163.3	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1438 to 1830.
911	14	165	1225	1730	1225 1730			-163.7	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
913	14	167	1401	1730	1401 1730			-163	12	29	-174	0	0.000	8	
914	14	168	1354	1730	1354 1730			-162.9	12	30	-174	0	0.000	8	
915	14	169	1225	1600	1225 1600			-163.3	12	18	-176	0	0.000	8	
917	14	171	1227	1730	1227 1730			-163	12	30.8	-174	0	0.000	8	
918	14	172	1225	1730	1225 1730			-163.1	12	29.4	-174	0	0.000	8	
920	14	174	1225	1730	1225 1730			-162.2	12	29.8	-173	0	0.070	8	P1/D1/B12 from 1225 to 1730. Maser 1 warm.
921	14	175	1225	1730	1225 1730			-163.3	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
922	14	176	1225	1600	1225 1600			-163.2	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1225 to 1600.
923	14	177	1225	1730	1225 1730			-163.5	12	17.1	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
924	14	178	1226	1730	1226 1730			-163.5	12	17.9	-176	0	0.000	8	P1/D0/B12 from 1226 to 1730.
925	14	179	1225	1730	1225 1730			-163.2	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1255 to 1730.
927	14	181	1746	2130	1746 2130			-162.8	12	16.9	-176	0	0.039	8	P1/D0/B12 from 1746 to 2130.
928	14	182	1225	1730	1225 1730			-163.2	12	17.1	-178	0	0.000	8	P1/D0/B12 from 1225 to 1730.

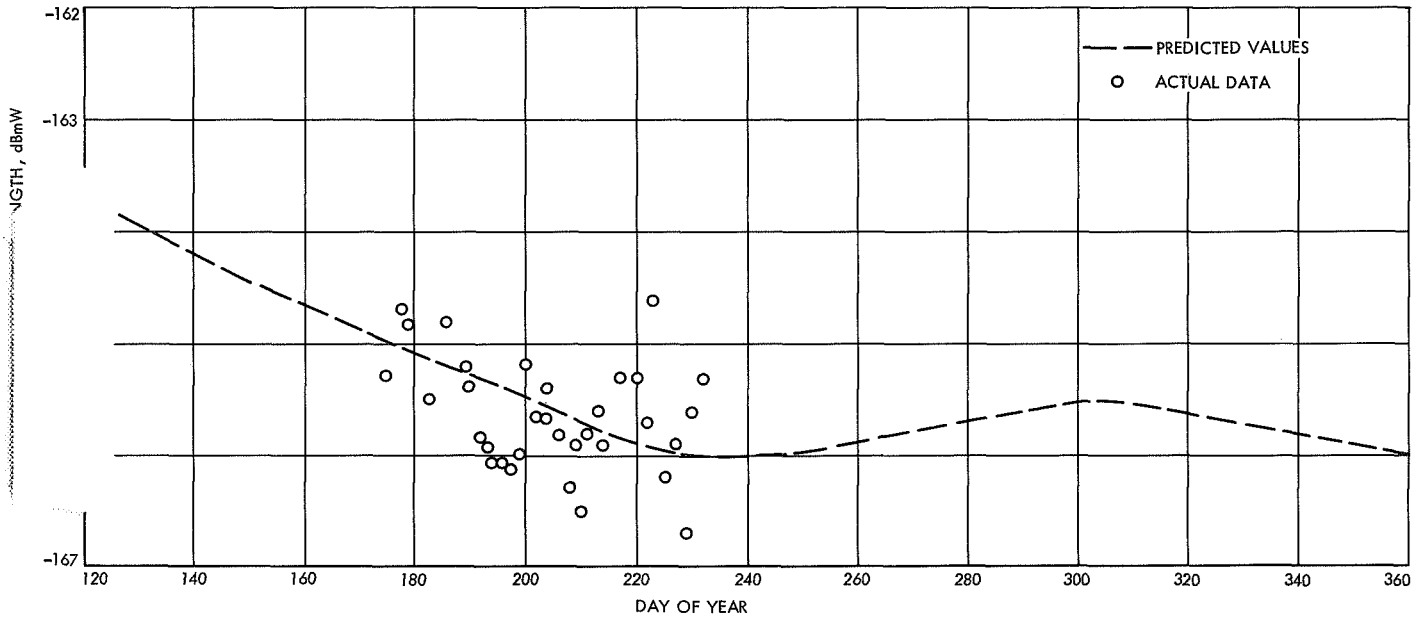

Fig. 23. Predicted and actual downlink signal strength vs day of year (August 1967)

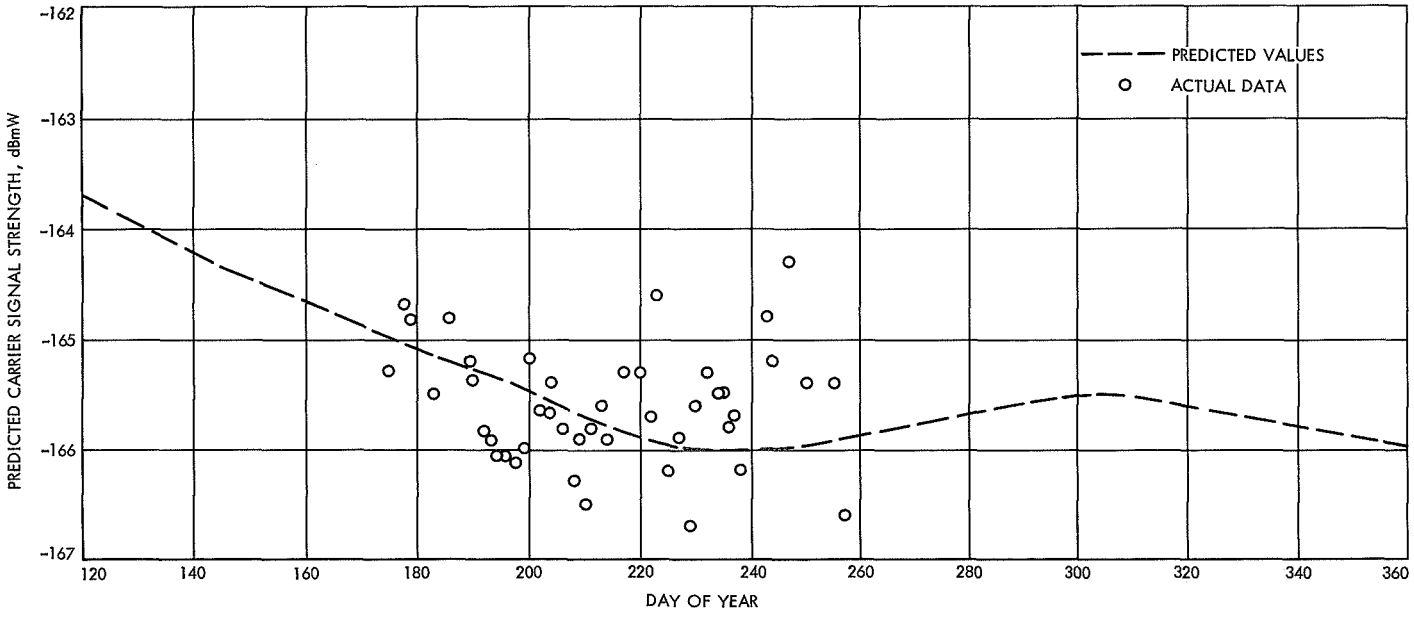

Fig. 24. Predicted and actual downlink signal strength vs day of year (September 1967)

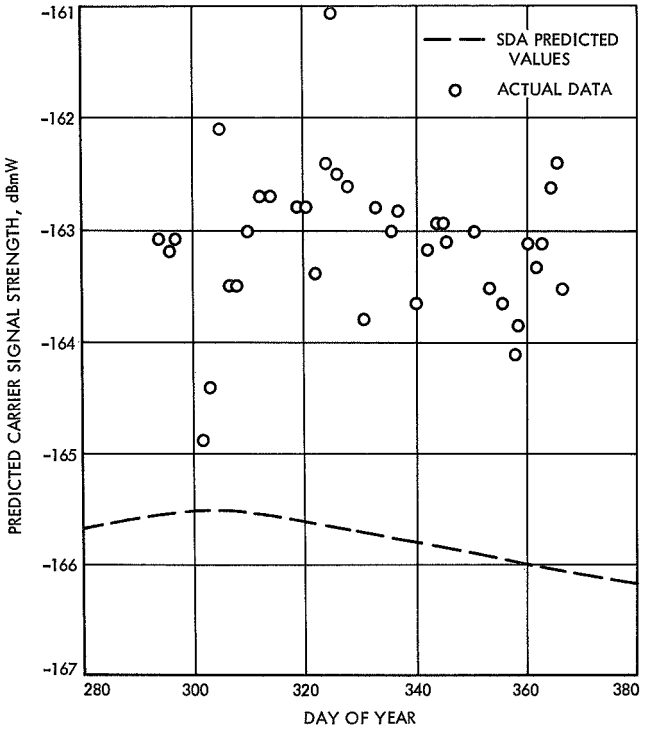

Fig. 25. Predicted and actual downlink signal strength vs day of year (October, November, December 1967)

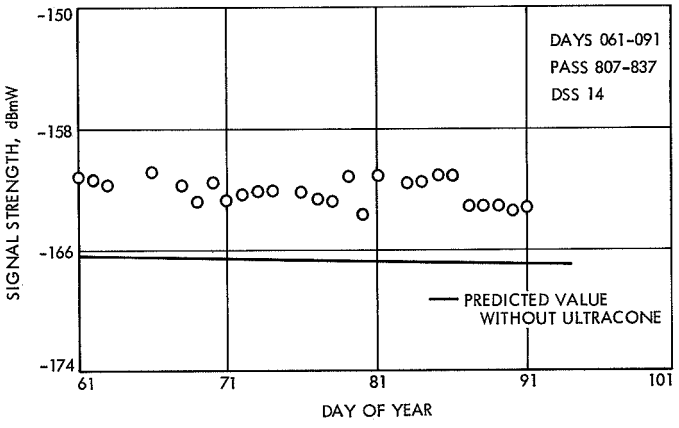

Fig. 26. Predicted and actual downlink signal strength vs day of year (March 1968)

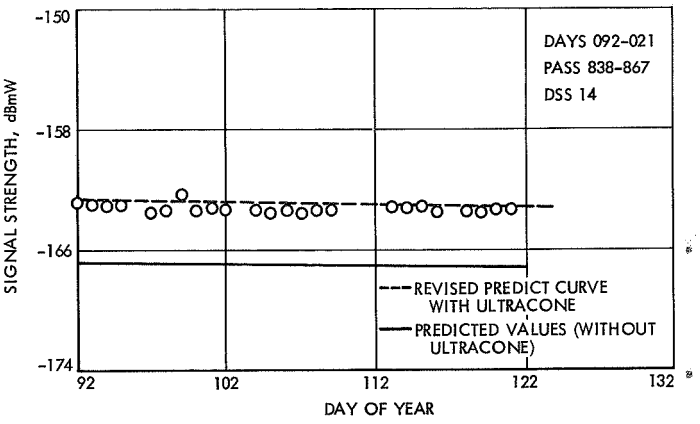

Fig. 27. Predicted and actual downlink signal strength vs day of year (April 1968)

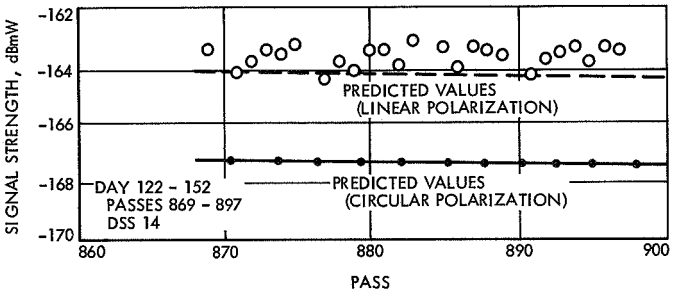

Fig. 28. Predicted and actual downlink signal strength vs pass number (May 1968)

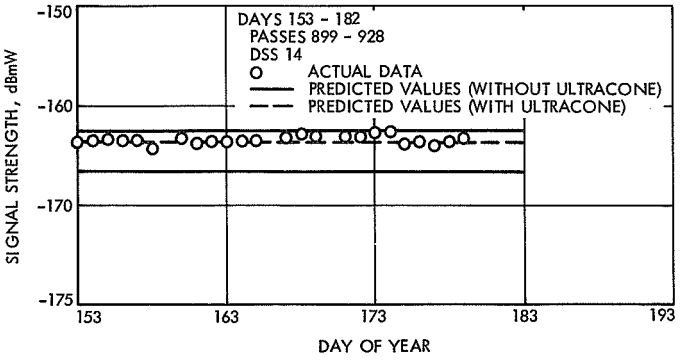

Fig. 29. Predicted and actual downlink signal strength vs day of year (June 1968)

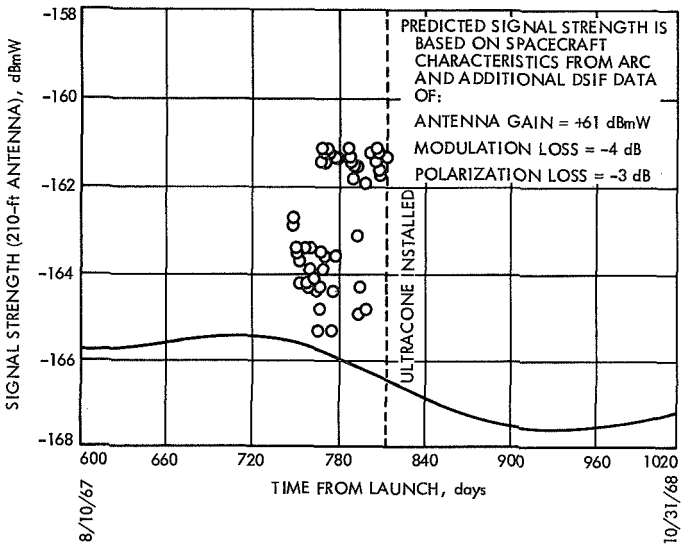

Fig. 30. Predicted and actual signal strength vs time from launch

2. Uplink. Uplink communication, as noted, proved unsatisfactory after February because of a failure in the spacecraft preventing use of channel 7 and the insufficient strength of the channel 6 low-gain antenna. Figures 31 through 34 illustrate uplink signal strength during the periods when uplink was accomplished and reported.

Signal strengths for DSS 14 during August are plotted in Fig. 31. The data lies in a bandwidth within ±2 dBmW of −137 dBmW. (Uplink signal strength for channel 7, then in use, had an average maximum of −137 dBmW.) Included in Fig. 31 is a plot of ground transmitter power as reported by the posttrack reports. During this time, passes 604, 605, and 608 were special uplink test passes for which the transmitter power was increased from the normal 10 to 20 kW. The average signal strength was −140 dBmW with the automatic gain control.

Passes 646 and 648 (September) were special communications processor tests employing channel 6 and receiver 1 (Fig. 32). The lower uplink signal strength, −142 dBmW, was consistent with the use of the low-gain antenna by receiver 1, channel 6. (The uplink signal strength for channel 6 normally had an average maximum of −136 dBmW for 20 kW ground transmitter power.) Use of channel 6 and the low-gain antenna, noted previously, later became a necessity.

During the final three months of 1967, an average uplink signal strength of −134 dBmW was recorded for channel 6, receiver 1 with 20 kW of ground transmitter power. This was about 5 dBmW less than recorded in previous months for channel 7, receiver 2 with 10 kW of transmitter power. This indicated that the low-gain antenna of receiver 1 provided a signal roughly 8 dBmW below that of the high-gain antenna used by receiver 2.

During January and February, transmitter power of 20 kW was used for all two-way noncoherent tracking.

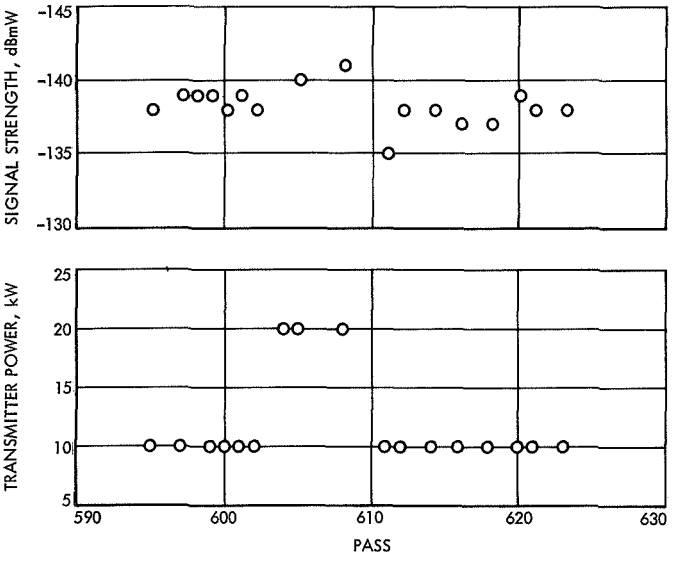

Fig. 31. Transmitter power vs uplink signal strength (August 1967)

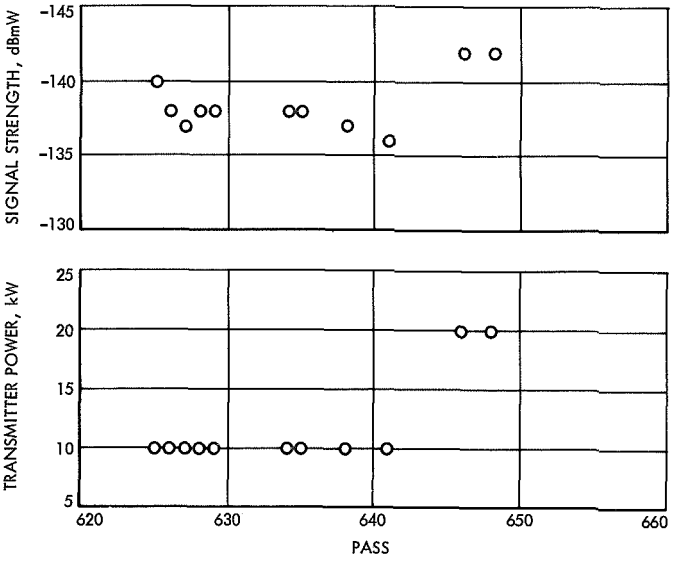

Fig. 32. Transmitter power vs uplink signal strength (September 1967)

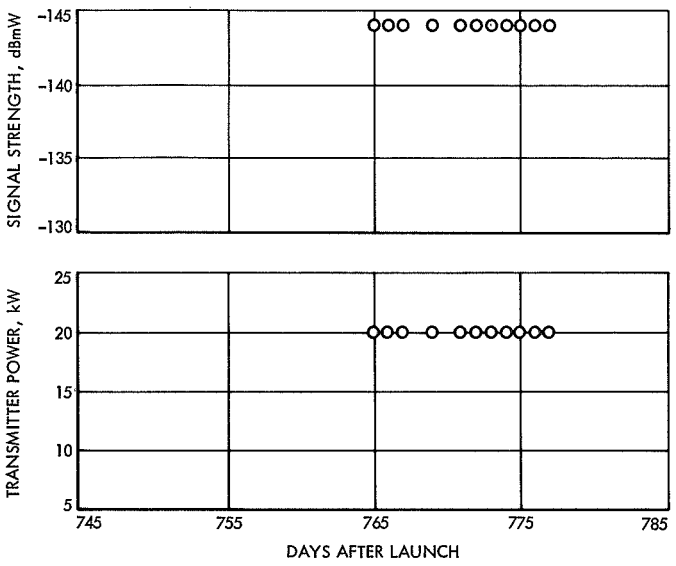

Fig. 33. Uplink signal strength and transmitter power vs days after launch, DSS 14 (1967)

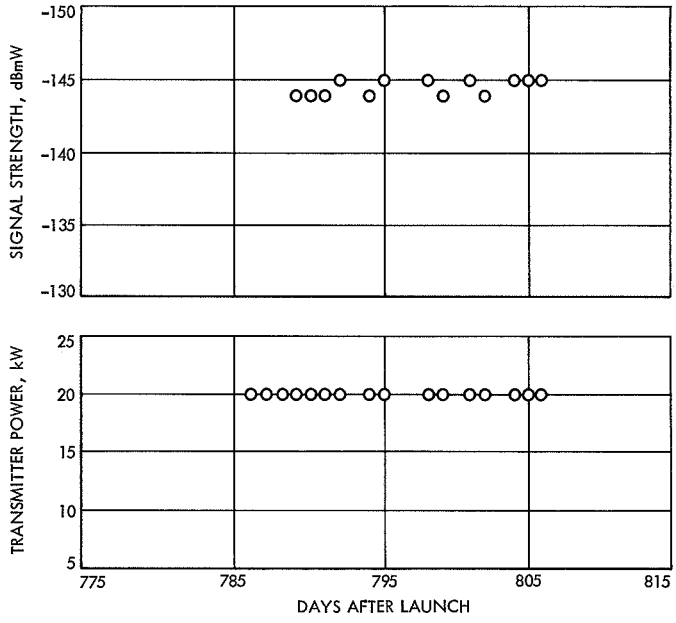

Fig. 34. Uplink signal strength vs time (February 1968), DSS 14

An uplink signal strength of −144 dBmW was recorded for each two-way noncoherent pass during January. The uplink signal was noisy and erratic during February (Fig. 34) compared with January, when all points fell on the −144 dBmW line.

3. Percent in-lock vs actual scheduled. Table 27 presents the overall actual minutes of radio frequency tracking vs minutes scheduled, plus the percentages of requirement fulfilled and the good data for several pass periods. During passes 595 through 623, 84% of all tracking data was good. The quality of the remaining 16% was degraded or lost because of the long RTLT and teletype outages. During that period, nearly 27 min was required to lock the receiver in two-way mode, resulting in at least 27 min of bad data per pass. During some passes, DSS 14 extended spacecraft interrogation beyond tracking commitment; actual minutes of tracking exceeded the scheduled time.

Table 27. Tracking in-lock vs actual and scheduled

Subsystem summary	Time, min	Percentage
Passes 595–623		
Scheduled	6092	100.0
Actual	6267	102.9
Transmitter on	6087	97.1[a]
Receiver in-lock (one- and two-way)	6193	98.8[a]
Good tracking data	5280	84.3[a]
Passes 625–648		
Scheduled	4346	100.0
Actual	4019	92.5
Transmitter on	3732	92.9[a]
Receiver in-lock (one- and two-way)	3964	98.6[a]
Good tracking data	3173	79.0[a]
Passes 747–777		
Scheduled	4005	100.0
Actual	4587	114.5
Transmitter on	2842	61.9[a]
Receiver in-lock (one- and two-way)	4587	99.9[a]
Good tracking data	3958	86.2[a]

[a]The indicated percentages are calculated with the actual time used as a reference.

E. Parity Error Rate

Average parity error and bit rates for DSS 14 are given in Tables 28 through 31. Figures 35 through 42 are plots of parity error rate vs downlink signal strength and day of year. (A parity error rate of 0.116 was equivalent to one error in 1000 consecutive bits of information and was regarded as the limiting value for the uncoded and convolution-coded unit modes of information.)

Table 28. Parity error rate,[a] passes 595–623, DSS 14

Pass	Day	Predicted downlink signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
595	214	−165.6	−165.4	0.07
597	216	−165.6	−165.8	0.17
599	218	−165.7	−166.3	0.10
600	219	−165.7	−165.9	0.12
601	220	−165.7	−166.5	0.15
602	221	−165.7	−165.8	0.11
604	223	−165.8	−165.6	0.21
605	224	−165.8	−165.9	0.41
608	227	−165.9	−165.3	0.26
611	230	−165.9	−165.3	0.14
613	232	−165.9	−165.7	0.16
614	233	−165.9	−164.6	0.14
616	235	−166.0	−166.2	0.17
618	237	−166.0	−165.9	0.22
620	239	−166.0	−166.7	0.10
621	240	−166.0	−165.6	0.04
623	242	−166.0	−165.3	0.09

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 29. Parity error rate,[a] passes 625–649, DSS 14

Pass	Day	Predicted downlink signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
625	244	−166.0	−165.5	0.08
626	245	−166.0	−165.5	0.04
627	246	−166.0	−165.8	0.08[b]
628	247	−166.0	−165.7	0.05
629	248	−166.0	−166.2	0.03
630	249	−166.0	Unscheduled pass	
634	253	−166.0	−164.8	0.04[b]
635	254	−166.0	−165.2	0.00
638	257	−166.0	−164.3	0.03
641	260	−166.0	−165.4	0.07
646	265	−166.0	−165.4	0.08
648	267	−165.9	−166.6	0.14
649	268	−165.9	Unscheduled pass	

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 30. Parity error rate,[a] passes 747–777, DSS 14

Pass	Day	Predicted downlink signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
747	001	−165.6	−162.8	No data
748	002	−165.6	−162.8	No data
749	003	−165.6	−163.3	No data
750	004	−165.6	−163.3	0.300
751	005	−165.6	−163.7	0.142
752	006	−165.6	−164.2	0.177
756	010	−165.7	−163.5	0.500
757	011	−165.7	−164.5	0.268
758	012	−165.7	−164.1	0.383
759	013	−165.7	−163.9	0.153
760	014	−165.7	−163.4	0.250
762	016	−165.7	−164.1	0.576
763	017	−165.7	−164.3	0.500
765	019	−165.8	−165.4	0.150
766	020	−165.8	−164.9	0.273
767	021	−165.8	−163.5	0.100
768	022	−165.8	−163.7	0.230
769	023	−165.8	−163.6	0.300
771	025	−165.9	−161.5	0.020
772	026	−165.9	−161.1	0.000
773	027	−165.9	−161.2	0.040
774	028	−165.9	−165.2	0.210
775	029	−165.9	−164.4	0.210
776	030	−165.9	−163.5	0.318
777	031	−165.9	−161.4	0.030

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 31. Parity error rate,[a] passes 786–806

Pass	Day	Predicted downlink signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
786	040	−166.04	−161.23	0.032
787	041	−166.05	−161.39	0.040
788	042	−166.05	−161.43	0.000
789	043	−166.06	−161.72	0.120
790	044	−166.07	−161.58	0.050
791	045	−166.08	−161.45	0.110
792	046	−166.09	−163.10	0.480
794	048	−166.12	−164.30	Bad
795	049	−166.13	−164.92	Bad
798	052	−166.15	−161.90	0.500
799	053	−166.17	−164.80	Bad
801	055	−166.19	−162.95	0.230
802	056	−166.20	−161.20	0.055
804	058	−166.23	−164.20	0.760
805	059	−166.24	−161.40	0.145
806	060	−166.24	−161.32	0.113

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

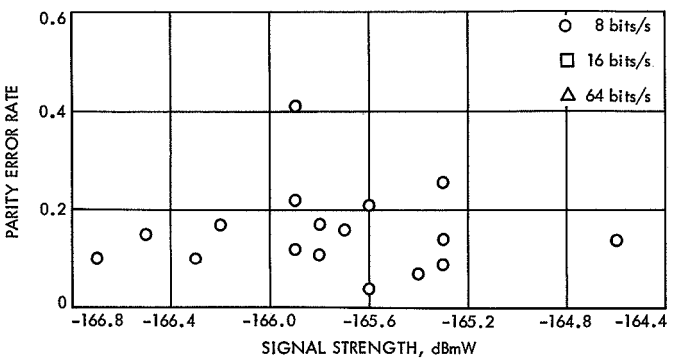

Fig. 35. Parity error rate vs downlink signal strength (August 1967)

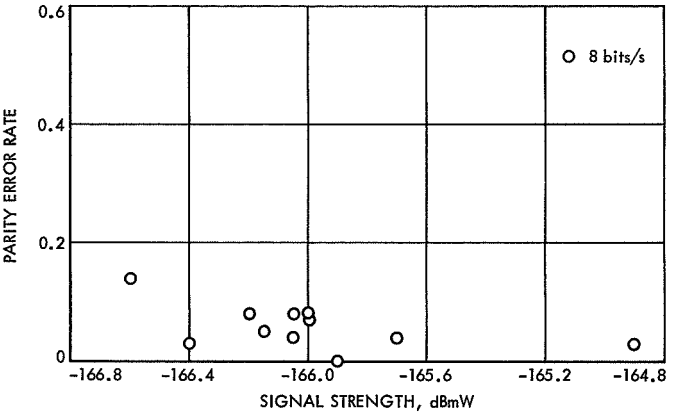

Fig. 36. Parity error rate vs downlink signal strength (September 1967)

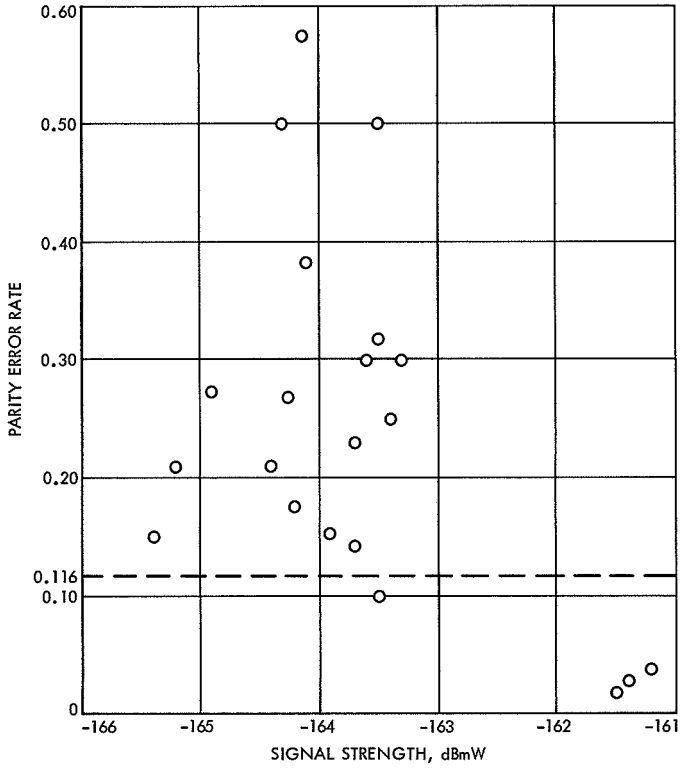

Fig. 37. Parity error rate vs downlink signal strength (January 1968)

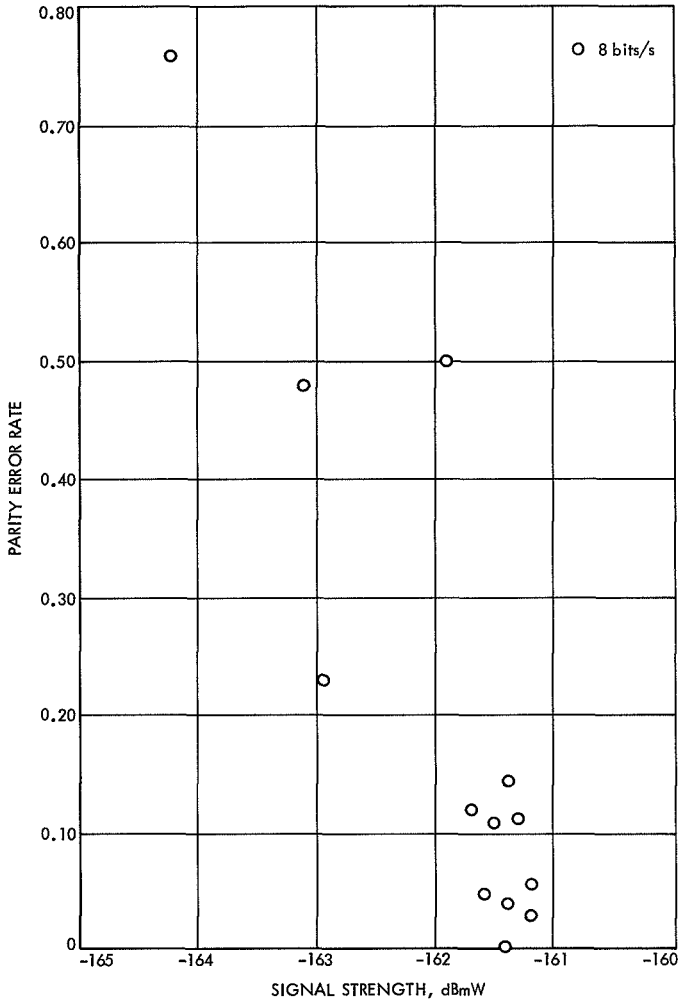

Fig. 38. Parity error rate vs downlink signal strength (February 1968)

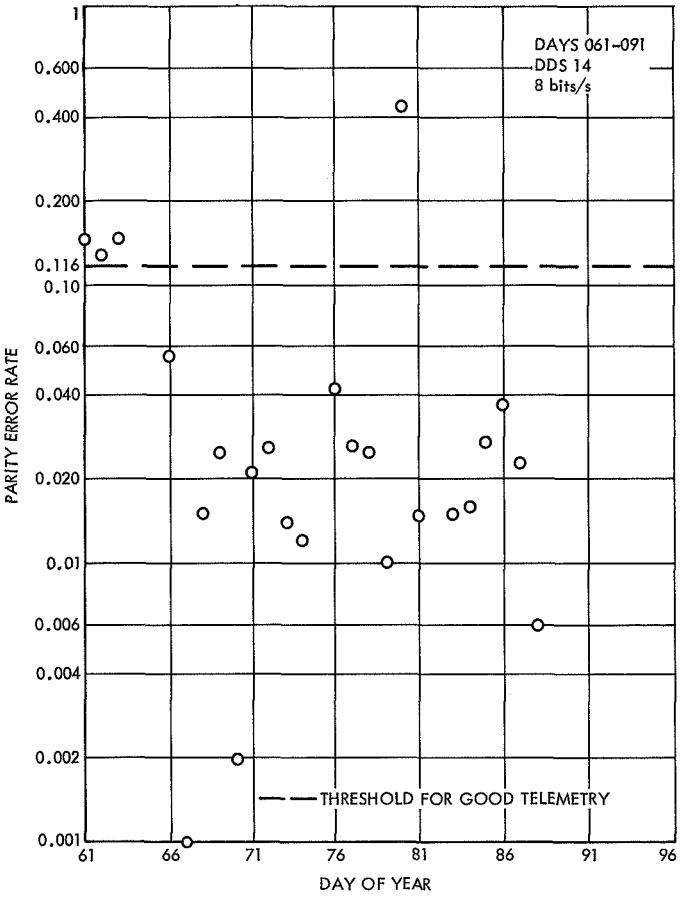

Fig. 39. Parity error rate vs day of year (March 1968)

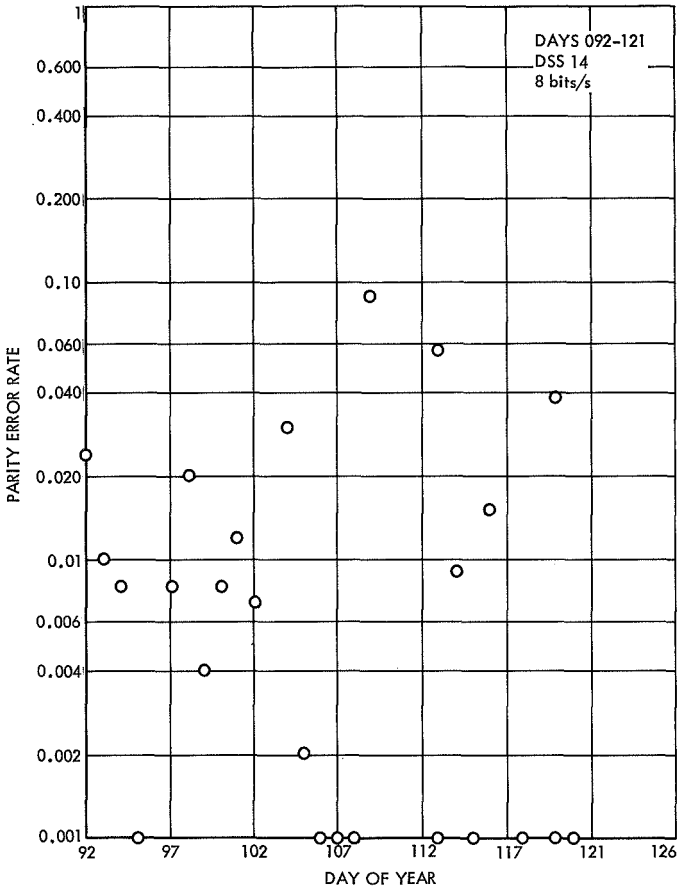

Fig. 40. Parity error rate vs day of year (April 1968)

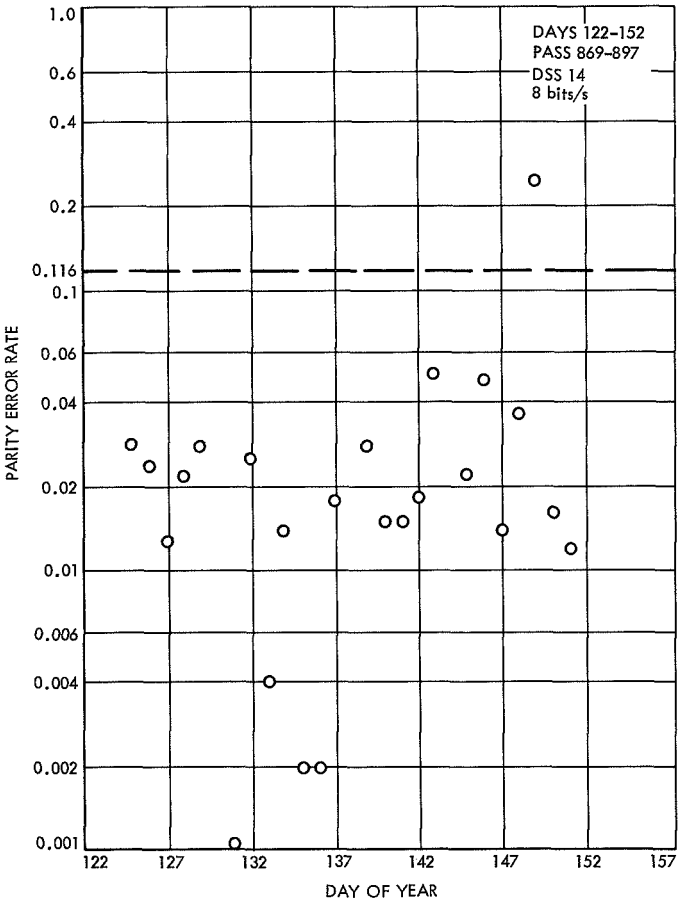

Fig. 41. Parity error rate vs day of year (May 1968)

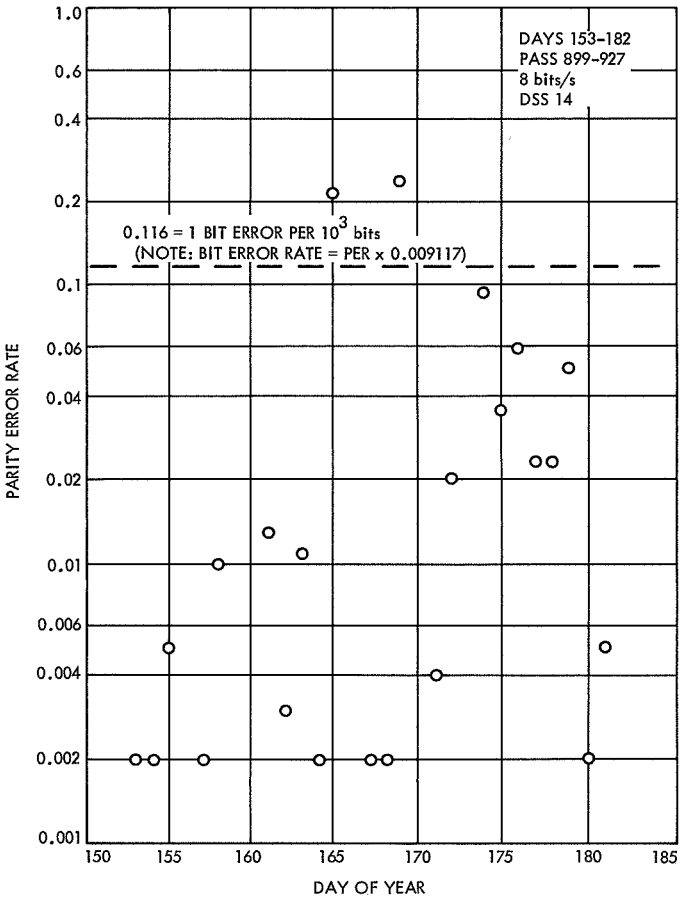

Fig. 42. Parity error rate vs day of year (June 1968)

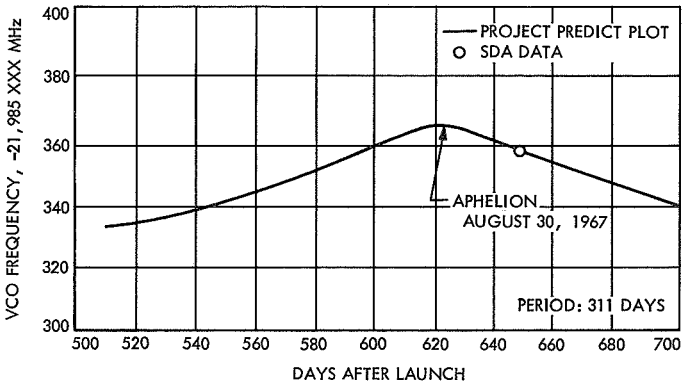

Fig. 43. Channel 6 best-lock rest frequency vs days after launch, passes 625–648

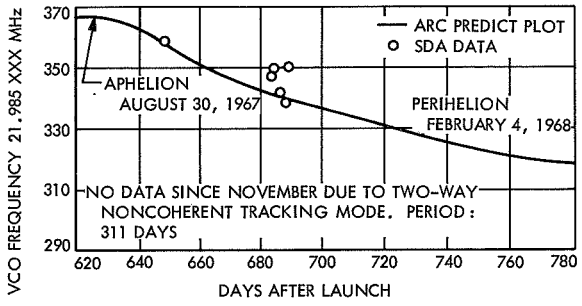

Fig. 44. Channel 6 best-lock rest frequency vs days after launch, passes 786–806

F. Predicted Frequency Performance

Pertinent information on channel 6 best-lock rest frequency is illustrated in Figs. 43 and 44. No data is presented after November 1967 because tracking was in noncoherent mode. Figures 45 and 46 present channel 7 best-lock rest frequency information, which was no longer received after October 1967. Figures 47 through 53 present auxiliary oscillator information through June 1968.

G. Interim Monitor Program Mean Residuals

Figures 54 and 55 are plots of the mean residuals printed out by the Interim Monitor Program (IMP), used to predict trajectories on a one-way mode, as a function of pass number. The data is printed out in real-time on a typewriter by the IMP at the ground station. For one-way tracking, the IMP computes the difference of the observed (O) one-way doppler frequency and the predicted (P) one-way frequency and prints out the mean for a prescribed sample interval as a function of GMT

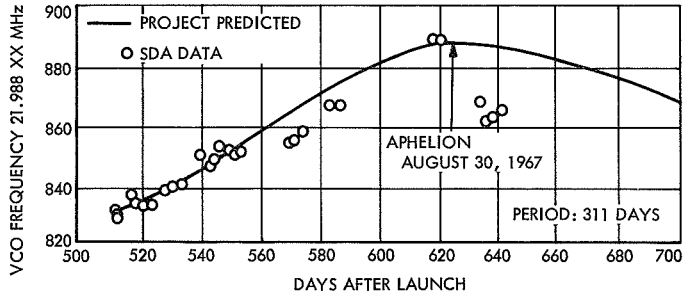

Fig. 45. Channel 7 best-lock rest frequency vs days after launch, passes 625–648

during the pass. Figure 54 shows that the auxiliary oscillator has changed from approximately +100 Hz to +400 Hz for the report period, December 1967. The slope, about +26.5 Hz per day, is an indication of the rate at which the oscillator changed frequency. Each value (Fig. 55) is an average for the pass of the mean, $\overline{X}$,

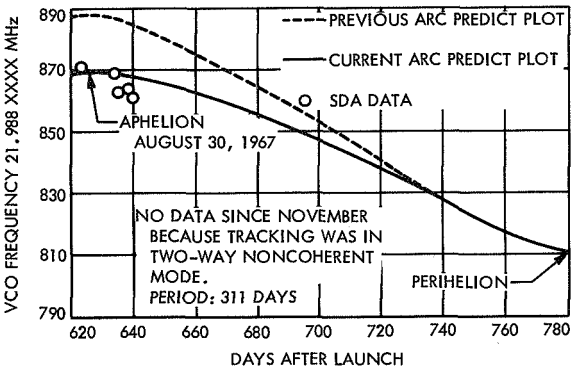

Fig. 46. Channel 7 best-lock rest frequency vs days after launch, passes 675–743

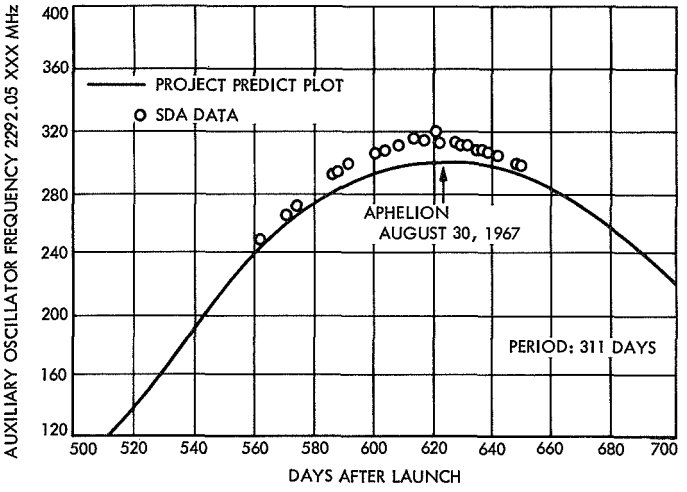

Fig. 47. Auxiliary oscillator frequency vs days after launch, passes 625–648

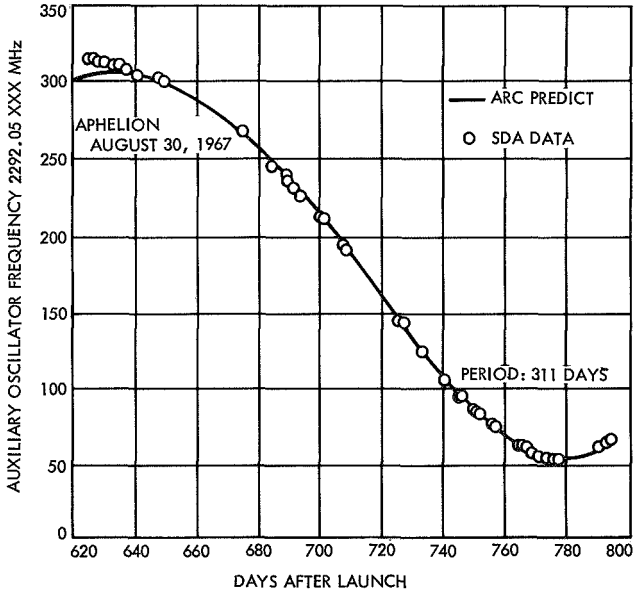

Fig. 48. Auxiliary oscillator frequency vs days after launch, passes 675–743

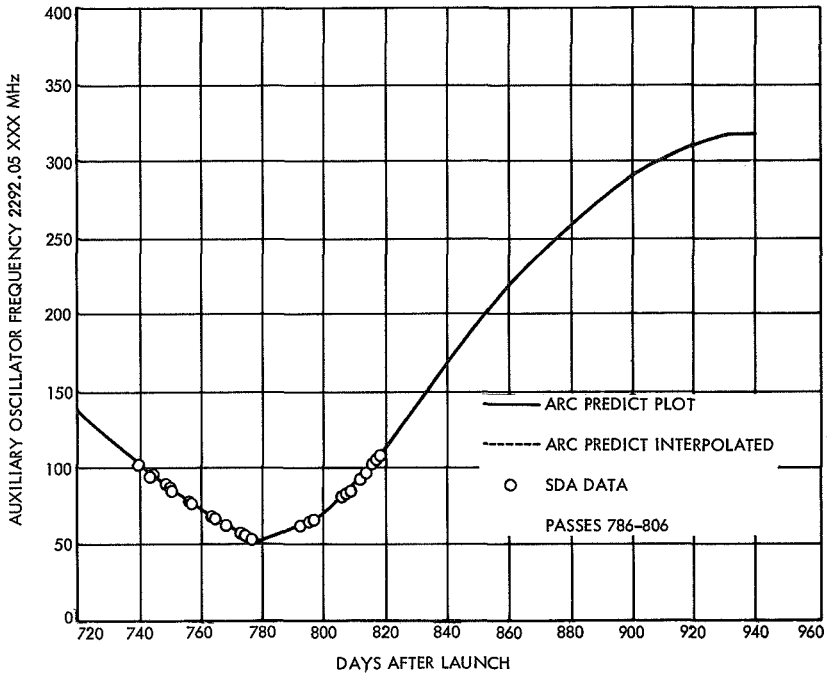

Fig. 49. Auxiliary oscillator frequency vs days after launch, passes 786–806

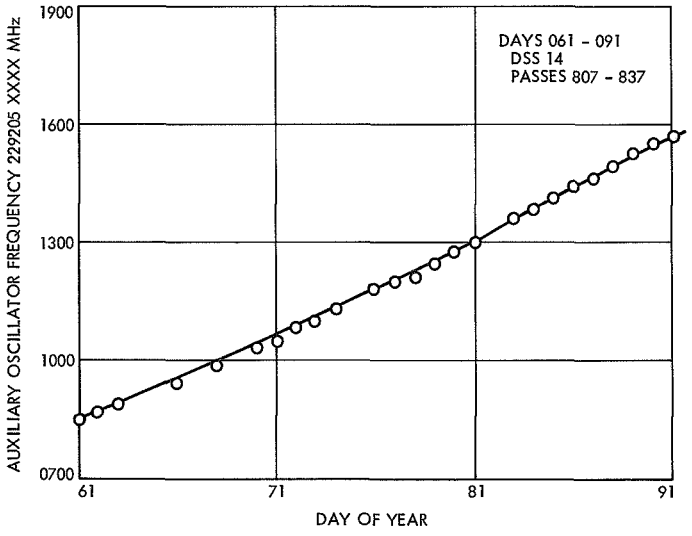

Fig. 50. Auxiliary oscillator frequency vs days of year, passes 807–837 (1968)

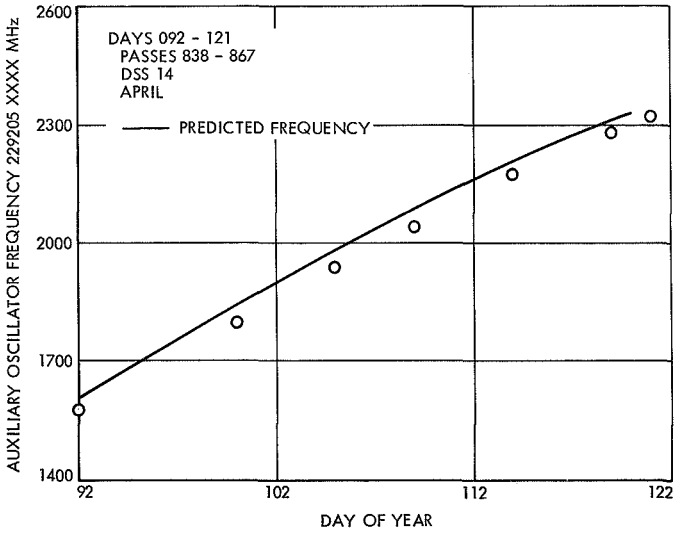

Fig. 51. Auxiliary oscillator frequency vs days of year, passes 838–867 (1968)

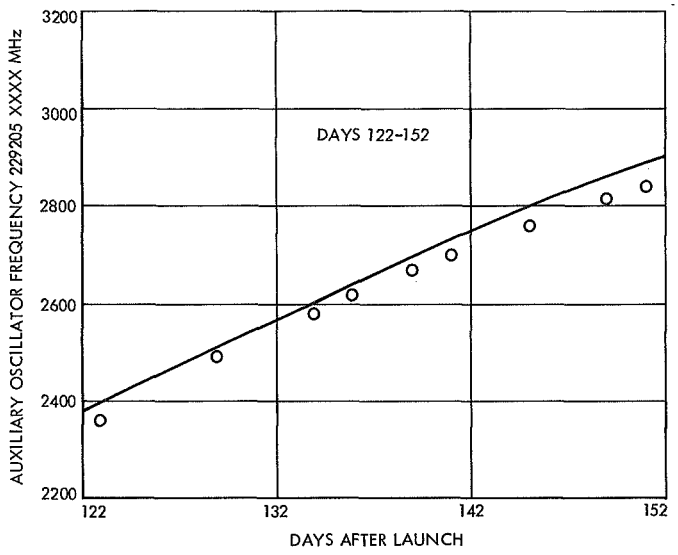

Fig. 52. Auxiliary oscillator frequency vs days after launch, passes 869–897 (May 1968)

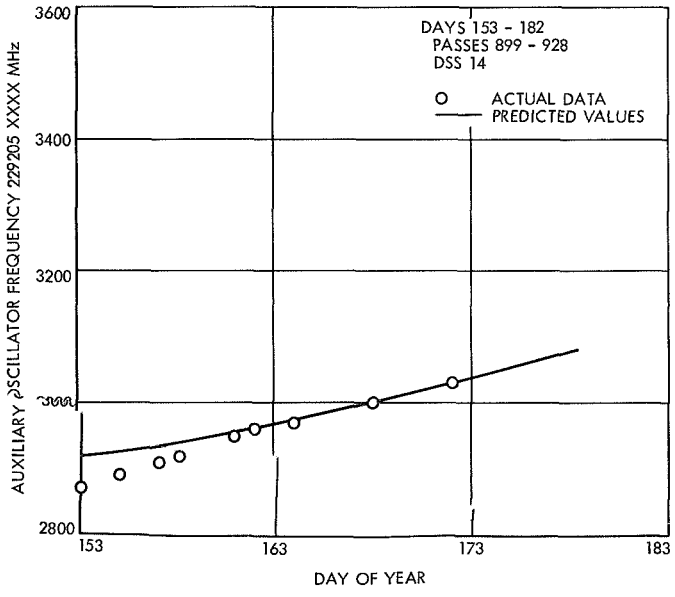

Fig. 53. Auxiliary oscillator frequency vs day of year, passes 899–928 (June 1968)

calculated by the program for each sample interval and printed out as a function of GMT, e.g.,

$$\overline{X} = \left[\sum_{i=1}^{7} (D_{oi} - D_{pi}) \right] \Big/ 7$$

where D_{oi} = observed doppler and D_{pi} = predicted doppler. The slope of the curve, +16 Hz per day, indicates the rate at which the frequency of the driver oscillator changed. The plot indicates that this value followed the predicted curve rather well in January 1968.

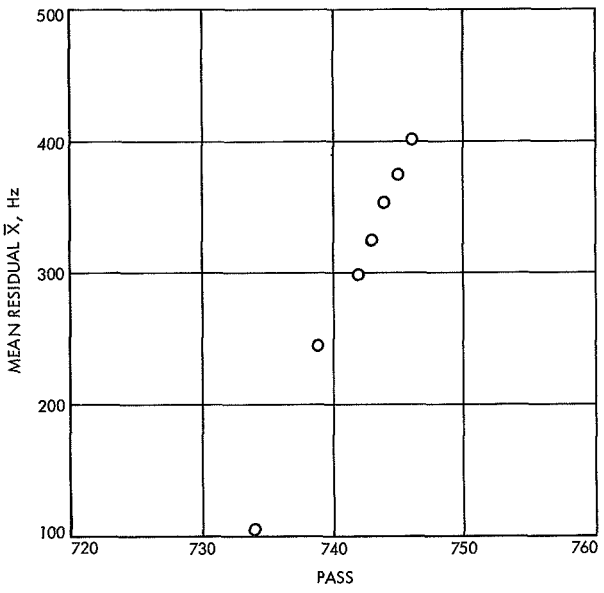

Fig. 54. IMP mean residual vs pass number, one-way mode (December 1967)

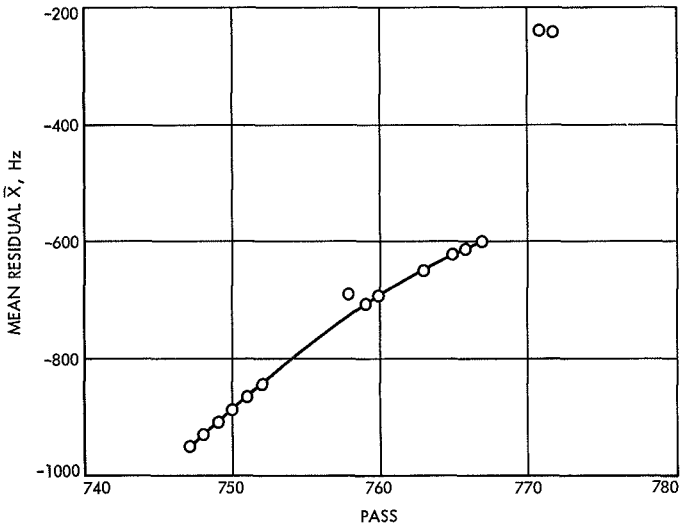

Fig. 55. IMP mean residual vs pass number, one-way mode (January 1968)

H. Predicts and Commands

Predicts generated for *Pioneer VI* to July 1, 1968, are presented in Table 32. The cumulative total of commands transmitted to *Pioneer VI* at the end of June 1968 was 5319. A total of 832 commands were transmitted

Table 32. Prediction summary, DSS 14

Predict No.[a]	Auxiliary oscillator frequency, MHz	Ground transmitter synthesizer frequency,[b] MHz	Coverage	Sample rate, s
68B	2292.052500	21.988880	7/1–8/1/67	900
69A	2292.052940	21.985360	8/8–8/18/67	600
69B	2292.053300	21.988885	8/1–9/1/67	900
70A	2292.052900	21.985362	9/1–10/1/67	900
70B	2292.052900	21.988885	9/1–10/1/67	900
71A	2292.052800	21.98535500	10/1–11/1/67	900
71B	2292.052800	21.98887000	10/1–11/1/67	900
72A	2292.052250	21.98534000	11/1–12/1/67	900
73A	2292.051336	21.98532800	12/1/67–1/1/68	900
74A	—	—	1/1–2/1/68	900
75A	2292.050680	21.98531900	2/1–3/1/68	900
75B	2292.05068000	21.98879800	2/1–3/1/68	900
76A	2292.05116000	21.98532500	3/1–4/1/68	900
76B	2292.05116000	21.98881000	3/1–4/1/68	900
77A	2292.05170000	21.98533100	4/1–5/1/68	900
77B	2292.05170000	21.98882600	4/1–5/1/68	900
78A	2292.05260000	21.98533100	5/1–6/1/68	900
78B	2292.05260000	21.98882600	5/1–6/1/68	900
79A	2292.053400	21.985331	6/1–7/1/68	900
79B	2292.053400	21.988826	6/1–7/1/68	900

[a]A = channel 6; B = channel 7.

[b]For best lock at zero doppler.

during this reporting period; attempts to transmit commands were abandoned after pass 837 at the end of March and were not resumed during the remainder of the period of this document. Previously, on pass 620 in August 1967, a total of 193 commands had been transmitted during a special orientation test (type II).

Before cessation of transmitting efforts, there were difficulties that periodically prevented command transmission. The history of these problems was given earlier. Commands by pass and day are presented in Table 26.

I. Pass Chronology

Tracking periods covered are identified by pass number, which is the number of times since launch that the spacecraft has been above the horizon of a particular station. Unless otherwise noted, the following entries refer to DSS 14.

Pass 567. Invalid hour-angle and declination readouts were caused throughout the pass by failure of the master equatorial at 1120.

Pass 573. The microwave line at DSS 12 was inadvertently disconnected, and a command did not reach the spacecraft.

Pass 575. This was a special unscheduled pass tracked by DSS 14 in addition to the regular scheduled tracking.

Pass 577. The tracking data indicated erroneous data condition code for 1 h 32 min, starting at 1038. The doppler column showed destructive count from beginning of track time until 1155 for the same pass.

Pass 580. A successful communications processor test was conducted using a new *Pioneer* operational computer program.

Pass 581. The TCP was unable to lock at 1102 at DSS 12, and 47 min of data was lost. The spacecraft was in duty cycle store.

Pass 584. The GOE at DSS 12 was unable to lock up the demodulator when the spacecraft was in one-way mode; 49 min of data was lost. The reason was not known.

Pass 585. Engineering data was missed at the beginning of the pass at DSS 12. The telemetry was transmitted upon completion of the track.

Pass 588. At 1736, a command was transmitted 1 *s* late.

Pass 591. At 1306, a command, transmitted just 1 min after the transmitter was turned on, was unable to reach the spacecraft. At 1400, DSS 14 reported a bit error rate greater than 1.0 at 16 bits/s. At 1350, the demodulator broke lock for 5 min and returned to help TCP lock.

Pass 592. The parity error rate recorded high; possibly this was the result of a Project delay in sending a command to lower bit rate from 64 to 16 bits/s. The parity error rate for all passes at 16 bits/s recorded high.

Pass 593. The transmitter klystron was detuned, delaying spacecraft acquisition time by approximately 7 min.

Pass 595. Recorded 2 h 40 min of extra one-way data.

Pass 601. The communications buffer failed at 1357. At 1404 the beta computer failed, and at 1440 the alpha computer was switched in. By 1550, the beta computer had been repaired; the TCP locked in at 8 bits/s at 1628.

Passes 604, 605, and 608. Special uplink power tests were held to measure the effect upon the ground station automatic gain control of 20-kW power (normally 10 kW) of the transmitter subsystem.

Pass 614. Two command numbers, 027 and 060, were not received by the spacecraft. At 1600, there was loss of telemetry as the result of a bad AIS patch cord.

Pass 616. At 1555, microwave link 10 between DSS 12 and DSS 14 failed, necessitating a switch at the communications center to line 7. A short loss of telemetry occurred. At 1713, the TCP lost W/F sync for 45 s.

Pass 620. A special test to orient the spacecraft so that the spacecraft high-gain antenna faced the earth was made. During this pass, 193 commands were transmitted to the spacecraft.

Pass 623. At 1634, the antenna lost the spacecraft signal because of pointing errors resulting from a malfunction in the azimuth channel of the autocollimator associated with the master equatorial. Tracking was intermittent.

Pass 634. The parity error rate was bad at 1157 and 1231 and was 0.022 at 1415. The bit rate went to 8 bits/s at 1245.

Passes 646 and 648. These were special communications processor test passes employing channel 6 transmitter at 20 kW. Several VCO frequencies were used.

Pioneer VI was not tracked between passes 648 and 675, September 24 through October 21, since DSS 14 was closed down for modification of equipment for support of *Mariner* Venus 67 encounter activities.

Pass 675. Word/frame sync was lost throughout the pass. This was a TCP or GOE problem, with the cause unknown. Transmitter power was increased to 15 kW for command transmission. The computer buffer was replaced to correct W/F sync. The command problem was investigated.

Pass 677. There were numerous losses of W/F sync at DSS 12 and DSS 14, a trouble-shooting problem. The transmitter power was 20 kW for command transmission. The computer buffer was replaced to correct W/F sync. The problem was investigated.

Pass 678. Although 23 commands were transmitted to the spacecraft, not all commands were effective. Network control reporting does not reflect which commands were effective. The TCP was in and out of lock many times throughout the pass.

Passes 683, 684, 686. Uplink control could not be established on channel 7. The problem was believed to be a spacecraft anomaly.

Pass 688. Frequent receiver glitches, probably the result of a spacecraft anomaly, caused bad parity error rate.

Pass 689. There was bad parity error rate in both one- and two-way coherent modes as a result of receiver glitches. Upon going noncoherent, the glitches stopped and the parity error rate was good. This was analyzed by ARC as a spacecraft problem. Systems Data Analysis (SDA) group reported that static phase error (SPE) was fluctuating from 5 to 20 kHz, indicating that receiver 2 was oscillating.

Pass 691. Two commands were not sent because of microwave line mismatch between DSS 12 and DSS 14. Project reported that none of the 13 commands were received by the spacecraft.

Pass 693. None of the commands were received by the spacecraft because of spacecraft anomaly.

Pass 695. The Systems Data Analysis group calculated that the signal appeared to be 2.5 dBmW better than theoretically predicted.

Pass 709. Stable DSIF transmitter output above 10 kW could not be obtained.

Passes 718 and 732. These were record-only passes.

Passes 724, 725, 726, 727. These passes were in the noncoherent tracking mode.

Pass 760. Receiver 2 was used as prime because automatic gain control volts for receiver 1 could not be monitored. The receiver 1 AGC amplifier and filter were replaced.

Pass 766. At 1450, there was a bad patch on the science data line through communications, but no data was lost.

Pass 768. Spacecraft uplink could not be acquired; the reason was not known.

Pass 769. Dual maser operation improved the parity error rate.

Pass 774. The dual maser was inoperative. The 400-Hz transmitter failed prior to the pass because of power fluctuations. The data was not affected.

Pass 788. Loss of commercial power delayed acquisition. There was a parity error rate of 0.000 based on one reading.

Passes 790 and 791. DSS 14 performed special tests on newly installed ground operating equipment, and the data from DSS 14 GOE was transmitted to SFOF for evaluation purposes only. The data from DSS 12 remained prime.

Pass 806. The transmitter was off at 1710 because of transmitter beam overcurrent.

Pass 812. DSS 14 was advised to track the spacecraft because of a Class III solar flare.

Pass 813. The transmitter was off because of arcing in the 400-Hz motor generator. The communication cable was cut by construction equipment, and communication was lost from 1845 to 2245. (DSS 14 had verbal instructions to peak the cone twice each hour. As part of the peaking action, the dBmW readings were dropped by a factor of 2.)

Pass 814. The 400-Hz power failed at 1300 and was off for 28 min. There were other power problems during the track. (In order to investigate the 400-Hz motor generator problem that arose during pass 813, the station was requested to turn the transmitter on at 10 kW and then increase the power slowly to 18 kW.)

Pass 818. At 1605, the demodulator would not lock up. Station 12 was brought up to support telemetry. At 1845, the power support of the 400-Hz fan was lost.

Pass 820. DSS 14 acquired the spacecraft in two-way noncoherent mode on channel 6, then switched to channel 7 at 1620. The spacecraft was acquired on channel 7 spacecraft receiver 2 at 1815 as indicated by an uplink signal strength of −144 to −140 dBmW.

Pass 822. On this pass and subsequent passes, the station acquired the spacecraft on channel 7 receiver 2 in two-way noncoherent mode.

Pass 827. The antenna was placed in brake mode at 1652:30 for 2 min because of an unauthorized crane in the area.

Pass 829. At 1619, a bad card was found in the doppler counter. From 1641, the transmitter power was unstable to the end of track because of cable arcing. The station time was found to be off by plus 2 s at 1802.

Pass 833. Doppler data was bad from 1715 to 1805. From 1719:30 through the remainder of the pass, the transmitter was off because of overbody current.

Pass 845. A communications cable to DSS 14 was inadvertently cut. This caused a loss of real-time data; however, all data was recorded on tape.

Pass 852. Approximately 1 h 50 min of real-time data was lost, and during passes 855 and 860 a smaller amount of data was lost. During these passes, the TCP program halted and had to be restarted many times in order to correct the data format. The problem appeared to be intermittent. A bad connector was replaced, but the investigation continued.

Pass 874. A commercial power failure caused 1 h 33 min of lost data. The loss of power caused an overload relay in the 400-Hz motor generator circuit to open; the problem was corrected by an electrician.

Pass 877. The real-time engineering and science data was garbled because of low line current, but all of the data was recorded on magnetic tape. The problem was

corrected by readjusting the current from the communications buffer.

Pass 889. The master equatorial torquer failed. Immediately following this failure, the antenna was switched to precision mode 2, which bypassed the master equatorial torquer and enabled the antenna to be driven directly. Acquisition was delayed approximately 6 min.

Pass 895. Fifteen min of data was lost when the antenna was positioned at zenith for signal variation check. However, no problem was discovered, and the antenna was returned to spacecraft point without further incident.

Passes 920, 921, and 923. DSS 14 had intermittent warmups on masers 1 and 2; each time the masers were purged and cooled down. All problems were traced to a contaminated helium bottle.

Pass 928. DSS 14 experienced two problems: (1) Receiver 1 failed to maintain lock in the 12-Hz tracking loop bandwidth; this was corrected by rephasing the reference loop. (2) A loss of telemetry to the demodulator/synchronizer occurred; the telemetry was restored by replacing a blown fuse in the telemetry and command data rack.